POWER

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Craftsmanship

IN a cathedral in a foreign city there is a beautiful mural painting. Its colors, though softened and subdued by age, are well preserved, and the artist who produced it might well exult to see this product of his inspiration, skill and genius transmitted unimpaired across the centuries—

Unimpaired except in one particular. In one place a sizable patch of the surface bearing the painting has spawled off, leaving an unsightly blemish in an otherwise perfectly preserved masterpiece.

Did the workman who prepared that surface realize that it was to bear the work of a master whose fame would grow with the ages and that it would be admired by travelers from lands of which he had never heard, when he and the artist had long returned to dust?

Old Father Time is perpetually busy destroying the works of man, and all of them must begin to fail somewhere and at some time; but how did the Enemy of All Things get the point of his scythe in at this particular spot?

Was the surface less carefully prepared for the reception of the mortar? Was the surfacing material itself less carefully mixed and applied?

There appeared to be no reason why the wall was stressed at that point more than at another. The spot was too high and inaccessible to have been due to an accidental blow. If the material was the same, applied with equal skill and thoroughness, why did it fail while so much other less important surface stood?

Perhaps it was not the workman's fault at all, but as the rest enthused about the painting, I wondered if that blemish was a record of some moment of inopportune interruption or abstraction; some hurry spot that an ancient workman had concluded would get by because it was near quitting time, or because some consideration more compelling than the determination that his work should live led to a momentary relaxation in his standard of craftsmanship.

F. R. Low

Fig. 1—Tripper unloads traveling bucket

Aërial Tramway Removes Ashes from Windsor Power Station*

By T. THORSTEN
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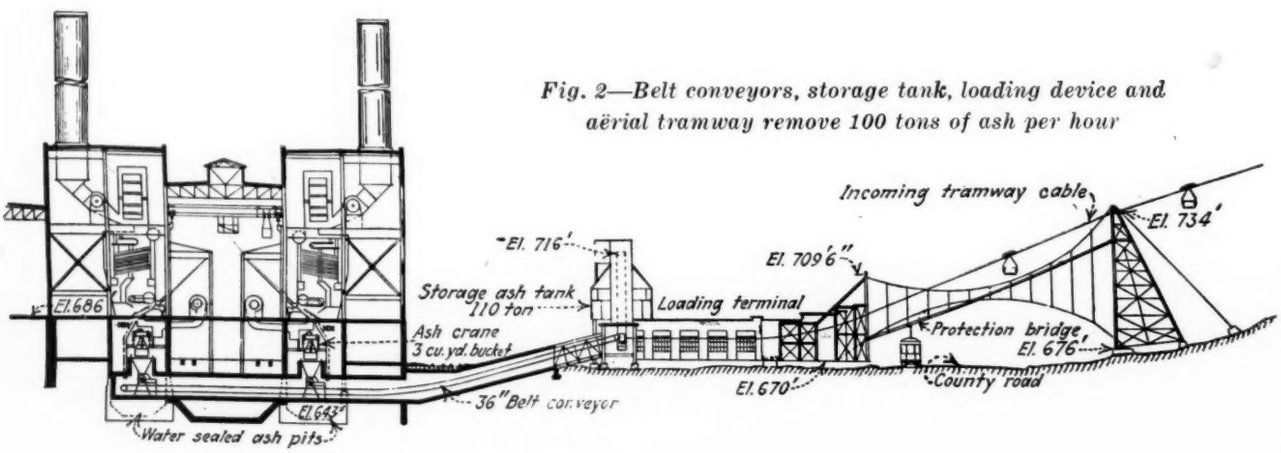
A BELT conveyor, storage tank and loading device supply buckets traveling on a cable over a mile in length, elevating the ashes 525 feet above the power station property. The buckets are unloaded automatically at the disposal ground and returned empty to the loading station. The tramway system has a capacity of 100 tons per hour operating 40 buckets of 35 cubic feet capacity each at a traveling speed of 400 feet per minute.

THE Windsor Power Station, operated under the joint ownership of the West Penn Power Company and the Ohio Power Company, is a mine-mouth plant of 180,000 kw. capacity, on the Ohio River twelve miles north of Wheeling, W. Va. Its location and surroundings determined largely the character of the ash-disposal equipment.

The most important requirements in the selection of the site for a large station, namely, a dependable coal supply sufficient for a long period and an adequate water supply, were here naturally provided. An element, however, that ranked perhaps next in importance was the removal of 600 tons of ash per day.

This problem admitted a diversification of attack. The choice of methods was influenced by the circumstance that in the immediate vicinity lay a tract of land too rough and hilly for cultivation and otherwise unsuited for development as a residential or industrial site. This area included a depression or valley of considerable size, available for filling. After studying the adaptibility of various methods of disposal in vogue elsewhere, the problem narrowed to that of transportation from the power station to the aforementioned area.

Fig. 2—Belt conveyors, storage tank, loading device and aërial tramway remove 100 tons of ash per hour



The system adopted and installed includes five distinct steps between the points where ashes are produced and where disposed of:

1. Water-sealed ashpits with nine days' storage capacity.

2. Grab buckets operated by cranes for removing ash from pits.

*An account of the belt-conveyor system at this station, which sorts, stores and transports coal, appeared in the Oct. 16, 1923, issue.

3. Belt conveyors for elevating ash from the power-station basement to the storage tank.

4. Overhead storage tank to equalize irregularity in rates of operation of conveying mediums.

5. Aërial tramway of the loop type for transporting ash from the storage tank to the disposal area.

The general arrangement of these elements is indicated in Figs. 2 and 3. A train of buckets spaced about 200 ft. apart continuously travels over the disposal area in a loop system. The stationary tripping device, Fig. 1, unloads each bucket automatically as it passes through this frame. While there may be nothing unique in the application of any one of these systems, it is believed that the combination that has been developed is novel and, by virtue of the economies effected in labor and maintenance, merits consideration in the design of large plants similarly located.

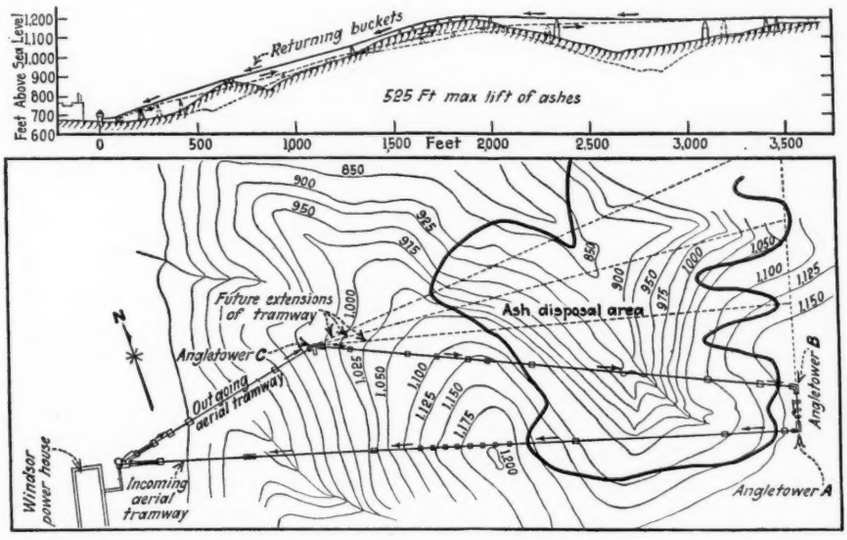


Fig. 3—Plan (below) and profile (above) of present and future ash-disposal systems

The advantages of the water-sealed ashpit, which has been described in numerous publications, are obvious to the operating engineer who has had to contend with air leakage, obnoxious fumes, maintenance of doors and gates, and objections otherwise encountered. Attention is directed to the important features, that by this arrangement combined with a suitable conveying system, is permitted a plant design having lower foundations and boiler furnaces with respect to river flood stages than would be required if railroad cars were employed to remove the ash from pits below the boilers.

Successful operation of the system, particularly the belt conveyors, requires the elimination of excess water from the ash before delivery to the conveyor feeders. The grab buckets, which have perforated shells, are of liberal capacity (3 cu.yd. each), which allows the crane operator an interval for draining the water from each bucketload of ash.

The use of a belt conveyor under these conditions is unusual, but with suitable feeding equipment it offers an efficient and satisfactory method of transportation. The feeder employed is of the rotary type, composed of disks similar to the grizzly screens used on coal tipples.

The fine material is screened to the belt first, and larger pieces are fed on top of this fine ash, thus reducing the abrasive action of the larger pieces on the belt surface. To reduce spillage of water from the belt to machinery parts, a width of 36 in. was employed, this being considerably wider than ordinarily required for a capacity of 100 tons an hour. Variable-speed motors on the belt drives allow regulation of the delivery rate to the storage tank so as to correspond with the loading rate of the tramway.

The general arrangement of the ash-handling plant, Fig. 2, includes first, a belt conveyor approximately 200 ft. in length which receives ashes from the hoppers and feeders below the crane runways, and transports them to a point outside the station. A second belt conveyor of the same size shown in the background of Fig. 4, running transversely, elevates the ashes to the top of the storage tank, which has a capacity of 110

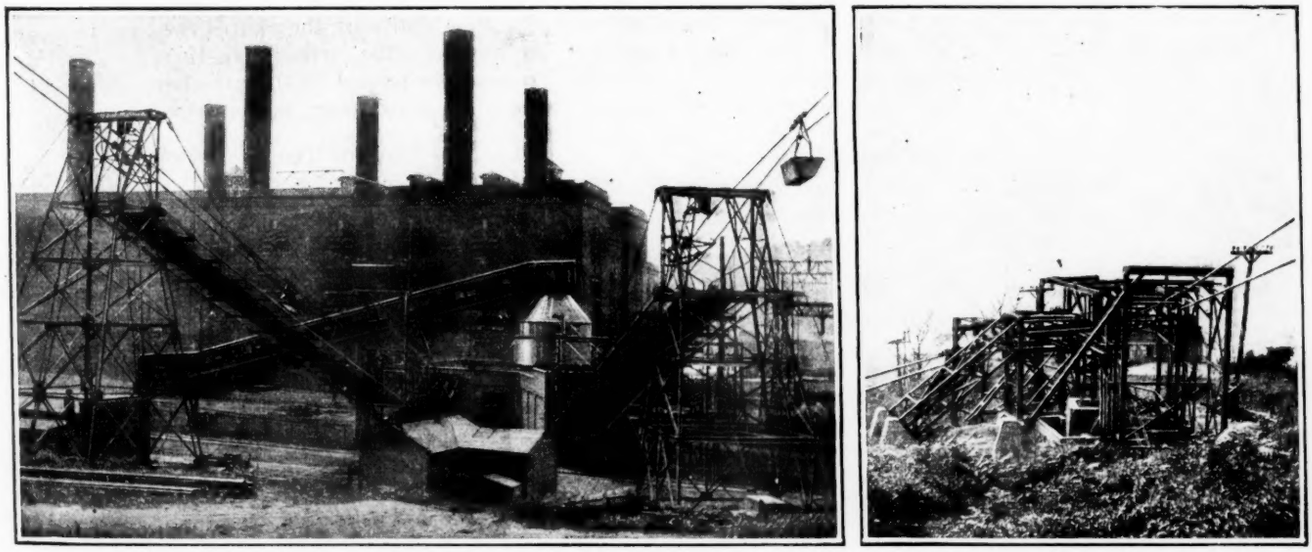


Fig. 4—Loaded bucket leaving incline for angle tower C (shown at right), then proceeds to the disposal area

tons, or slightly more than the hourly capacity of the transporting equipment.

Empty tramway buckets enter the loading terminal and receive ashes delivered through chutes from the storage tank, Fig. 5. These chutes are equipped with air-operated gates controlled by an attendant within the loading terminal. Four openings at the base of the tank are equipped with air-operated control gates. In addition to the two chutes leading into the loading terminal, there are two rotatable chutes which will deliver ash to railroad cars, electric traction cars or to auto trucks. Steam coils are installed in the inclosed

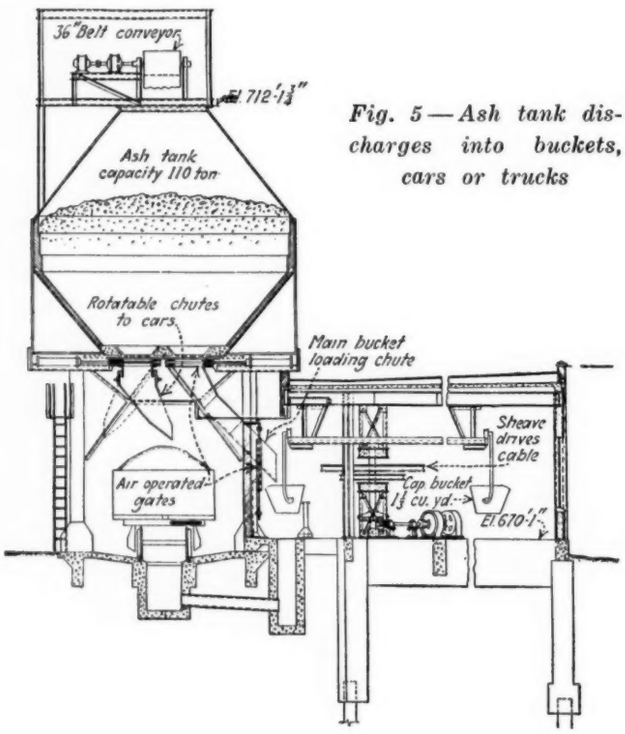


Fig. 5 — Ash tank discharges into buckets, cars or trucks

space at the lower portion of the tank, to prevent freezing in cold weather.

As aërial tramways have not been in general use outside of the mining industry, this part of the ash-handling plant will be described more in detail, particularly since this tramway is a comparatively large installation as regards hourly capacity and size of buckets, and it encounters rather steep grades.

The tramway system is of the loop type, which permits ash discharge over a wide area with the initial installation and makes it possible to alter the course of a portion of the system at a later period with minimum delay and expense. Ash output from the power station can probably be handled for eight years before any change will be necessary; later shifts will be required at more frequent intervals. The area available will accommodate the station ash output for a period estimated at twenty years.

The Aërial Tramway

The plan and profile of the tramway system, Fig. 3, shows the power station in the lower left-hand corner with the two belt conveyors leading to the storage tank at the corner of the loading terminal. The courses of the outbound and inbound lines diverge at an angle of 28.6 deg. from a point inside the loading terminal. Outside the loading terminal both lines cross the county road at grades of about 37 and 42 per cent. The profile shows in dotted lines the outbound line and surface of the ground below it, while the inbound line is in solid lines.

A tramway bucket is suspended from a carriage having four wheels designed to run on $1\frac{3}{4}$ in. diameter track cables. Attached to the yoke or bail is the mechanism that grips the $\frac{3}{4}$-in. diameter traction cable and the latch that holds the bucket in an upright position. Both devices have projecting levers which engage with fixed counterparts on the tramway structures for automatic operation. The cable grip detaches for the loading operation and re-attaches for exit. The bucket latch trips as it passes the tripper frame, Fig. 1, allowing the bucket to turn upside down by gravity on its trunnions and discharge the contents.

Bucket Loading Equipment

The loading terminal shown in Fig. 4 is a steel structure supported on piling, with a brick exterior harmonizing in appearance with the power station. It houses the machinery for driving the traction cable, the grip detaching and attaching mechanisms, chutes and control gates, and provides space for a repair shop for tramway buckets. At the right of this, but not shown, is the anchorage to the counterweight which maintains a constant tension of 70,000 lb. in the track cable. At the left is the ash-storage tank and the housing over the belt conveyor.

The traction cable that pulls the tramway buckets around the 7,365-ft. course at a speed of 400 ft. per min., is driven by a 10-ft. diameter grip wheel, mounted on a vertical shaft shown in Fig. 5. This grip wheel is driven by a 100-hp. 720-r.p.m. motor, in connection with an inclosed speed-reduction unit and bevel gears. The traction cable leaving the grip wheel passes over a sheave and thence to another sheave attached to a counterweight below the floor, returning to the proper elevation again over the second sheave in the background. This maintains a uniform tension in the cable, compensating for changes in cable length due to stretch and temperature.

The bucket grips are detached from the traction cable before reaching the grip wheel, and the momentum of empty tramway buckets carries them from the detacher to the vicinity of the chutes, whence they are moved by hand to the proper position for loading. Loaded buckets are passed to the attacher, after which the traction cable draws them to the disposal area.

Bridges Protect Trolley System

The chutes, Fig. 5, are equipped with undercut gates operated by compressed air. The valves and piping in the foreground control the operation of the air cylinders which are mounted against the wall adjacent to the gates that they move.

Loaded tramway buckets leaving the loading terminal pass over the county road and the Wheeling Traction System trolley line. To prevent annoyance to traffic due to spillage, protection bridges of the suspension type were installed under the track cables crossing the road, as in Fig. 2. Each of these bridges supports a wide pan or trough which is intended to catch any spillage and drain it toward the loading terminal. The structure is designed to withstand the shock resulting from the fall of a detached bucket, should such an accident

occur. A loaded bucket leaving the terminal and an empty bucket returning may be noticed in this view.

At a point on the outbound line 1,178 ft. from the loading terminal the tramway is deflected about 37 deg. at a structure designated as angle station C and 82 deg. at angle station B. As will be noticed in this view, the tramway encounters grades that would be difficult to surmount with other modes of transportation.

The tramway buckets travel over a rail through angle station B and thence over a rail supported by a latticed girder to angle station A. This girder is supported at intervals by three bents. The use of a rail over the short span between these stations saved the installation of a counterweight, which would have been required had a track cable been installed.

Movable Tripper Empties Buckets

The tripper frame, Fig. 1, may be moved to any desired position along the track cable and anchored by clamps to the track cable. It is provided with a projecting member which throws the latch on the yoke of the tramway bucket, allowing the bucket to turn upside down by gravity and discharge its contents. In this view a bucket is leaving the tripper frame.

The bucket in Fig. 1 has just passed the tripper frame and is discharging its contents. The tripper is at present located about 300 ft. from tower No. 14, and at this point the track cable is 150 ft. above the ground. The loaded buckets on the outbound line appear to be 200 ft. apart, which is the scheduled spacing for a capacity of 100 tons an hour.

PERTINENT FACTS REGARDING THE ASH DISPOSAL SYSTEM

Total length of tramway, ft.	7,365
Elevation of track at loading terminal, ft.	680
Elevation of track cable at highest point, ft.	1,208
Maximum height ashes lifted, ft.	525
Number of towers for supporting track cable	28
Height of tallest tower, ft.	107.6
Longest cable span, (Tower No. 10 to Tower No. 11), ft.	900
Tension in track cable, lb.	70,000
Speed of traction cable and buckets, ft. per min.	400
Motive power installed, hp. motor	100
Capacity of tramway, tons per hour	100
Capacity of tramway buckets each, cu.ft.	35
Capacity of ash storage tank at terminal, tons	110
Ratio: $\frac{\text{Disposal Area Capacity}}{\text{Annual Ash Accrument}}$ =	20
Excavation for Foundations, cu.yd.	1,805
Concrete in piers and foundations, cu.yd.	1,782
Structural steel, total, tons	390

The A. Leschen & Sons Rope Co., in conjunction with the mechanical engineering department of the West Penn Power Company, prepared designs for the steel supporting structures. Preliminary engineering, design of bridges and other details, and installation were also handled by the West Penn organization. Excavation for foundations totaled 1,800 cu.yd., and 1,780 cu.yd. of concrete was placed in piers and building foundations. Approximately, 390 tons of structural steel was required for the twenty-eight towers, three angle stations, loading terminal and protection bridges. Other high lights are given in the table.

It is believed that the aërial tramway offers the most economical means of transporting ashes from the power station. The daily ash output of the plant may be disposed of in an eight-hour shift by one crane operator, three loaders, and one supervisor who looks after tramway equipment outside of the loading terminal.

When sections of $\frac{1}{8}$ in. or less in thickness are to be joined by means of an electric-arc weld, the edges need not be beveled, but they should be separated a small amount instead.

Cost of Atomizing Fuel Oil

From a questionnaire sent by *Chemical & Metallurgical Engineering* to twenty-four manufacturers of fuel oil burner equipment, the following over-all installation costs were calculated:

Boiler Heating Surface. Sq.Ft.	Mechanical Atomizing System	Steam Atomizing System
1,500	$5,000	$3,000
3,000	7,000	4,000
9,000	15,000	9,000
19,500	23,000	14,000
45,000	45,000	30,000

These figures include the cost of burners, strainers, duplex pumps, heaters, underground storage tank, all necessary piping, valves, fittings and meters, together with the cost of installation under average conditions.

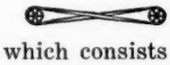
In computing the total operating costs a fixed charge of 22 per cent has been assumed. If steam is used for atomization, 2.5 per cent of the total steam generated by the boiler is used, and this is charged at the rate of 80c. per 1,000 lb. A 1,500-sq.ft. boiler plant operating 24 hours a day 300 days a year, at normal rating will use 1,000 gal. of oil, and other plants in proportion. The costs in plants of various sizes are given in the table, based on an evaporation of 3 lb. of steam per square foot of heating surface.

COST OF ATOMIZING FUEL OIL

	Mechanical Atomizing	Steam Atomizing
1,500-sq.ft. of boiler:		
Steam cost or power cost	$0.48	$2.48
Fixed charges	3.67	2.20
Total	$4.15	$4.68
3,000-sq.ft. of boiler:		
Steam cost or power cost	0.96	4.96
Fixed charges	5.13	2.93
Total	$6.09	7.89
Cost per 1,000 gal. oil	3.05	3.95
9,000 sq.ft. of boiler:		
Steam cost or power cost	$2.88	$14.88
Fixed charges	11.10	6.60
Total	$13.98	$21.48
Cost per 1,000 gal. oil	2.33	3.58
19,500 sq.ft. of boiler:		
Steam cost or power cost	$6.24	$32.24
Fixed charges	16.87	10.26
Total	$23.11	$42.50
Cost per 1,000 gal. of oil	1.87	3.27
45,000 sq.ft. of boilers:		
Steam cost or power cost	$14.40	$74.40
Fixed charges	33.00	22.00
Total	$47.40	$96.40
Cost per 1,000 gal. oil	1.58	3.21

No charge for labor is included in the cost of atomizing oil.

A study of the data shows that the size of the plant has but little effect on the cost of atomizing oil. This is because the expense items of atomization, with the exception of fixed charges on the plant, are directly proportional to the quantity of oil atomized. Another important point is that in no case is the cost of atomizing the oil a determining factor in the choice of fuels. Fluctuation in the price of fuel oil is the big factor. For example, a charge of one cent in the price of oil is relatively important, as compared to the cost of atomization.



Admiralty alloy, which consists of about 70 per cent copper, 29 per cent zinc and 1 per cent tin, has been found to be the most suitable composition of metal for use in steam condensers where sea water, brackish, muddy or polluted water is used as the cooling medium. In cases where the cooling water is fresh and clean, condenser tubes consisting of 70 per cent copper and 30 per cent zinc may be used with good success.

Unaflow Engine Practice of a Century Ago

In 1827 Jacob Perkins Operated Unaflow Engines with 800-Lb. Steam—Invented a Compound Engine of High Economy

THE origin of the so-called central-exhaust steam engine, or, as it is generally termed, the unaflow engine, is one not known to many. With some few exceptions engineers assume that it is a modern invention, in spite of the fact that one hundred years ago (1825) the single-acting uni-directional-flow engines were being built in series, in various sizes, by Jacob Perkins & Son in England. Since Perkins displayed an extraordinary appreciation of the merit of a large expansion ratio in the cylinders and the advantage of high steam pressures, the history of his work is of great potential value to the operating engineer of today.

THESE notes on the work of Jacob Perkins are based on researches made by Charles R. King. In view of the difficulties encountered with high pressures in present day power plants, the fact that Jacob Perkins successfully employed steam at 1,500 lb. pressure should induce modern engineers to investigate his system. Examination of periodicals of that day reveals much of the opposition this American encountered in England.

As outlined in *Power*, May 6, 1924, Perkins was an American citizen who emigrated to England and invented a number of mechanical contrivances, many of which are still in active commercial operation in England. His greatest work was the invention of the compound unaflow engine and the high-pressure boiler.

Both before and after using the unaflow principle, Perkins sought to reduce the amount of heat going to the condenser, through abstracting a part of this heat by the circulation of water around the unaflow exhaust pipe. This heated water was then fed back to the boiler, this being perhaps the first attempt to so utilize waste heat. The process was patented June 5, 1825.

By costly experiments in his London Works he evolved his system of a valveless exhaust as applied to an ordinary "Watt" cylinder, so developing the "unaflow" in the simple, and later in the compound type. Both these engines were types tested either by pumping on public works, or by brake tests, before many eminent engineers of that day, and their economies created such an impression that the technical and popular-science journals of the whole world devoted large space to their description and working results. The German publications, notably *Dingler's Poltechnische Journal*, and French journals gave more space to the unaflow engine than do present-day magazines of similar scope.

Reconstructed with any modern valve gear and subject to modern working conditions, the Perkins engine would no doubt prove as economical as its descendant, the unaflow of today. At the present time the simple unaflow engine is being superseded in England by the compound unaflow by demands for higher economy.

In 1827 Thomas Telford, first president of the Institution of Civil Engineers, was building the new St. Catherine Docks. The *London Journal* states on page 287 of the volume of 1827: "This small engine of Perkins has been within the last few days set up and employed in pumping work for the excavation. There are four engines engaged in the prosecution of this work. Mr. Perkins' engine stands alongside a low-pressure engine of 16 horsepower, as decided by the area of the piston. Mr. Perkins' engine cylinder is 8 in. by 20 in. and has been making 60 strokes to the minute. It is connected by gear to a beam making 16 strokes to the minute in raising two alternating pump buckets; the diameter of each is 14 in. with a stroke of 3 ft. 6 in."

In an official record of the operation of this engine the statement is made: "We, undersigned, James Lamon, Pearson Woodward, Thomas Browne, hereby certify that there are two low-pressure engines employed night and day discharging the water which flows into the St. Catherine Docks from land springs, etc.; one of them is of 16 horsepower and the other 10 horsepower. We also certify that Mr. Perkins has recently put up a small high-pressure steam engine, the diameter of whose piston is 8 in. and its stroke 20 in., and that we have seen his engine pump the same quantity of water from the docks which has heretofore been pumped by the other two."

Henry Hornblower and William Herne also testified that the unaflow engine in doing this work used but 42 lb. of coal per hour, while the low-pressure engines of Boulton & Watt make required triple that quantity to do the same work. When the B. & W. engines were shut down for repairs, the Perkins engine ran for a week continuously, day and night, and with no oil.

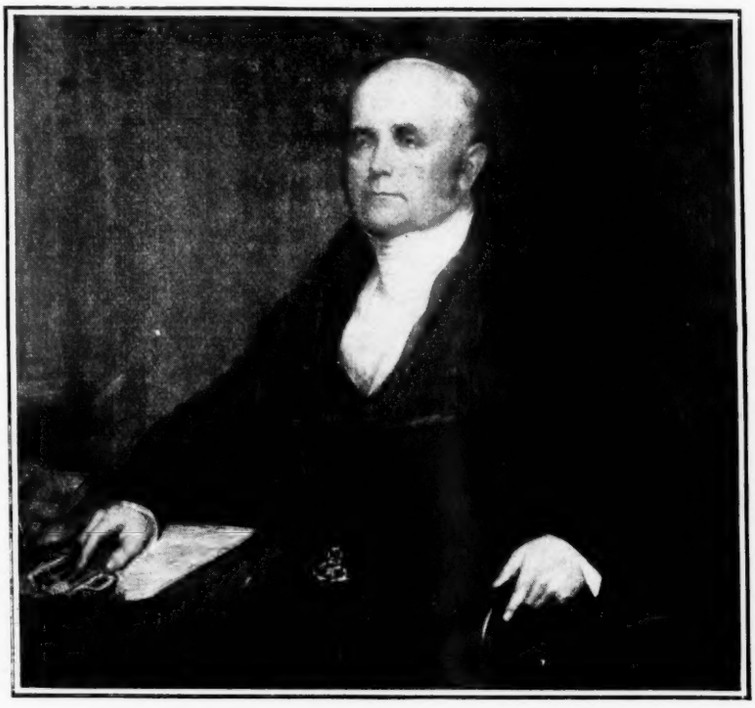
While the unaflow principle was responsible for much of the coal economy, the increase in pressure over the 3 to 5 lb. used by Watt was an extreme advantage.

In the *London Journal* of 1827, pages 99 to 104, are reports on the high-pressure Perkins unaflow at St. Catherine Docks: "The steam, it was said, was under a pressure of 27 atmospheres, although Mr. Perkins usually employs 56 atmospheres. Under a pressure of 800 lb. to the inch, steam is admitted until the piston has moved through one-eighth of its stroke, then ingress of the steam is cut off and the other seven-eighths of the stroke are performed by expansion." The detailed description of the boiler following, includes

the statement: "It is a safety valve in itself; many rent tubes took place at first, but during the last two years nothing of the kind has occurred, although the steam has been raised to above 1,500 lb. to the inch."

Perkins appreciated the value of many expansions and consequently adapted the unaflow principle to the compound system as invented years before by Hornblower, but who was forced to drop its manufacture through a lawsuit instituted by Boulton & Watt for "infringement." The latter firm urged, of course, that compounding gave no more power than would a single cylinder, and was supported in this contention by Professor Robson's classic theory; although Watt's own engines were, later on, compounded by McNaught with 50 per cent fuel saving.

The advantage of compound expansion when using high-pressure steam was understood by Perkins, who simply added on a low-pressure cylinder to his standard unaflow engine, with 60 per cent power increase on equal steam per hour. The *London Journal* on page 98 of the 1827 volume refers to this engine as follows: "Mr. Perkins has erected at his factory a very complete engine having two single-stroke cylinders connected together. The volume of steam already expanded in the first cylinder drives the piston down where an enlargement in that cylinder allows the steam to escape into the upper part of the large cylinder."



Reproduction of Portrait of Jacob Perkins

Another journal, also describing this engine, notes that the steam pressure was 800 lb. per sq.in. The small cylinder had a bore of 8 in. and a 20-in. stroke; while the low-pressure cylinder, added to it, was 22⅝-in. bore by 20-in. stroke. High-pressure cutoff was at ⅛ stroke. It is stated that at equal steam consumptions the power in compound expansion was doubled over the unaflow working "simple," and the machine much less cumbersome than the Watt engines.

It is obvious that the use of pressures of 400 to 800 lb. introduced difficulties with boilers. In the opinion of moderns, materials and workmanship in those times were not of the present day's great merit. This seemed also to have been the idea of a writer signing himself "M.M." who, in the *Mechanics Magazine*, London, 1840, while describing the new Perkins boiler wherein superheated steam, in closed tubes, forms the evaporative heating surface, delivers a long diatribe against its possibilities. Yet one of those boilers was not removed from active and efficient service at Hoat's, London, until the Great War—when that "M.M." writer, Jacob, Angier March and Loftus had all long passed out of memory. The boiler had then been in use for 65 years and another of the same system, by its side, 34 years; and yet, when broken up during removal in 1915, the fireman who had attended them for ten years found the superheating tubes that evaporated the water, and originally carried a pressure of 1,500 lb. per sq.in., were practically as good as new after having served as water-grate firebars for all those years. While one may say such materials were then of "no great merit," we know well that no modern boilermaker would care for his generators to similarly outlast his grandchildren's steam plants. The Perkins engines were constructed with great refinements and in the most robust form, utterly without comparison with the uncouth Boulton-Watt engines of his day. Yet the earliest of all Watt engines at Birmingham can still be operated at a higher pressure, 7 lb. per sq.in., than that for which they were designed. We must therefore drop some of the cherished myths, now current, that do duty to prevent inquiry into the methods by which the ancients made high-pressure steam the success that still baffles the modern designer.

Another of the periodicals, criticizing his system, remarked that the simple unaflow at the St. Catherine Docks had obvious defects. Thus, the cam valve drive affixed to the flywheel let the drop valve fall down, at every stroke, with a percussion that shook the entire engine. In those days of extremely low pressure the Watt pistons were usually packed with candlewicking soaked in tallow. Perkins invented the flexible "no-oil" piston ring. Following upon Barton's successful metallic rings for pistons and piston valves, Perkins, in 1823, patented an oilless ring which, in the official abstracts, is stated to be a metallic flexible expanding piston ring with spiral springs placed over and below the opening in the elastic ring. These rings were of alloy, the working of which always gave a mirror-like surface to the cylinder walls, and apparently became quite frictionless. The composition was frequently given in the journals of 1827-28 and was later stated by Loftus Perkins to be 5 parts tin and 15 parts copper. It was also mentioned that with 400 lb. pressure the rings lasted 100 days. L. Perkins' own regular working pressure was 700 lb. per square inch.

Jacob used an exceptionally heavy runner head in casting his engine cylinders which, he said, gave a casting with a dense grain resembling wrought iron. He at first found that the metal stained, or pitted, if left standing for a time after the engine had been operated without cylinder lubrication. Conceiving this

trouble to be due to an electrochemical action, he introduced zinc in the cylinder, which prevented this pitting.

The inventor, in a paper to the Institute of Civil Engineers, London, in 1836 said: "I have often been asked why I did not follow up my patent. My answer has been that soon after I had completed those experiments (brake tests on the unaflow compound) my moneyed partner failed and his creditors put the patent in chancery, where it now remains."

There was, beyond the loss of his patents, another obstacle. This was the antagonism of Boulton & Watt, which firm, quite properly for its own commerce, fought every improvement of the steam engine in order to preserve its trading monopoly. The Edinburgh *Philosophical Journal* of 1823 remarks: "The steam engine of Mr. Watt has so long been considered as the greatest triumph of science that it is deemed a sort of heresy to regard it as capable of improvement, and notwithstanding all that has been done by Mr. Woolf and other eminent engineers, the undoubted merit of their inventions has scarcely yet been admitted by the public. Under such circumstances Mr. Perkins' claims are likely to meet with warm opposition. Instead of treating it as an invention which would do honor to the age in which we live and to add a powerful arm to British industry, the jealousies of rival traders are arrayed against it. It is due to the candor of philosophical history to mention that Mr. Perkins is not our countryman, but the age of jealousies against America is happily past."

In 1829, R. S. Stuart, in his "History and Anecdotes of the Steam Engine," who was a keen Watt champion, says: In looking at Mr. Perkins' labors, the mass of prejudice with which he has been, and continues to be, assailed forcibly arrests the attention. Keeping the great value of his inventions totally out of view, his is no mean share of merit for the steadiness of purpose with which he has been borne up against the interests and spleen arrayed against him, for it cannot be concealed that his exertions have been spoken of in terms contemptuous and harsh, although they have been of that meritorious kind that even failure in them should have brought him honor."

His unaflow patents having been impounded for debt, he, like anyone else, was debarred from building unaflows until his patents elapsed or they were released from chancery, but so convinced was he of the value of the una-directional principle that he actually retained its use by a different, or "camouflaged" method, which, up to the present day, has not been reinvented.

The Throttling Calorimeter vs. the Barrel Method

By L. G. Jones

Some time ago I had occasion to determine, with the regular throttling calorimeter, the quality of exhaust steam leaving an engine, and out of curiosity, having a small tank handy, I decided to check the old barrel method. The results were noteworthy and are tabulated herewith.

For sampling the steam, a ½-in. perforated tube was inserted about two-thirds of the way into the 8-in. exhaust pipe, and connections made thereto.

A standard Schaeffer & Budenberg calorimeter was used in the first test, with the regular thermometers, pressure gages, etc. The data taken were as follows:

Barometer ..... 14.4 lb.
Line-steam pressure (exhaust steam used for heating purposes) .....14.5 lb. gage
Temperature steam in calorimeter.....214 deg. F.
Pressure in calorimeter, 0.09 in. of mercury or practically atmospheric

The symbols and data used in the formula were as follows:

H = Total heat of saturated steam in calorimeter, 1,150.4 B.t.u. per lb.
q = Heat in liquid of line steam, at 28.9 lb. absolute pressure ..... 216.6 B.t.u. per lb.
r = Latent heat of vaporization of line steam, 947 B.t.u. per lb.
C_p = Specific heat of steam at 213 deg. F. and atmospheric pressure .....0.47 B.t.u. per lb. per deg. F.
T_2 = Temperature of superheated steam in calorimeter, at atmospheric pressure .....214 deg.
T_1 = Temperature of saturated steam in calorimeter, at atmospheric pressure .....212 deg.
x = Per cent steam vapor in line steam, or quality of steam.

$$x = \frac{H + C_p(T_2 - T_1) - q}{r} = \frac{1150.4 + 0.47(214 - 212) - 216.6}{947}$$

= 0.986 or 98.6 per cent steam and 1.4 per cent moisture.

This test was repeated with the same results, 98.6 per cent quality.

For the second test a small tank of about 20 gal. capacity was filled about half full of water and weighed. A ¼-in. connection was extended from the ½-in. sampling tube in the steam line, so that the open end of it dipped under water almost to the bottom of the tank. Steam was first allowed to blow into the air for a few minutes to heat the tube.

The valve was then opened and steam allowed to flow for about seven minutes into the tank, during which time the water was stirred with a wooden paddle to insure thorough mixing and correct temperature readings. The temperature of the water was taken at frequent intervals, before, during and after the steam flow. A loss of 1 per cent was assumed, due to radiation, conduction, etc. The following data were obtained:

Weight of water plus tank.....95¾ lb.
Weight of tank empty.....19¾ lb.

Weight of cold water.....76 lb.
Temperature of water, final, after steaming.....129.2 deg.
Temperature of water, original, before steaming.. 60.8 deg.
Rise in temperature of water. ..... 68.4 deg.
Total heat absorbed by water, 76 lb. × 68.4 deg. × 1.0 Sp. Heat = 5,198 B.t.u.
Radiation, conduction, etc., losses, 1 per cent.... 52 B.t.u.
Total heat input.....5,250 B.t.u.
Weight of tank, water and steam (condensed).....100¾ lb.
Weight of tank and water..... 95¾ lb.

Weight of steam used.....5 lb.
Temperature of steam in line.....246.2 deg.
Temperature of final water.....129.2 deg.

Drop in temp. of steam.....117 deg.
Heat lost by cooling of condensed steam, 5 lb. × 117 deg. × 1.0 Sp. Heat = 585 B.t.u.
Net heat lost by steam by condensation only.....5,250 − 585 or 4,665.4 for 5 lb. or 933 B.t.u. per lb. of steam
Latent heat of vaporization of steam at 14.5 lb. gage, 947 B.t.u. per lb.
Quality of steam tested $\frac{933.1}{947}$ = 0.985 or 98.5 per cent

The comparative results by the two methods were:

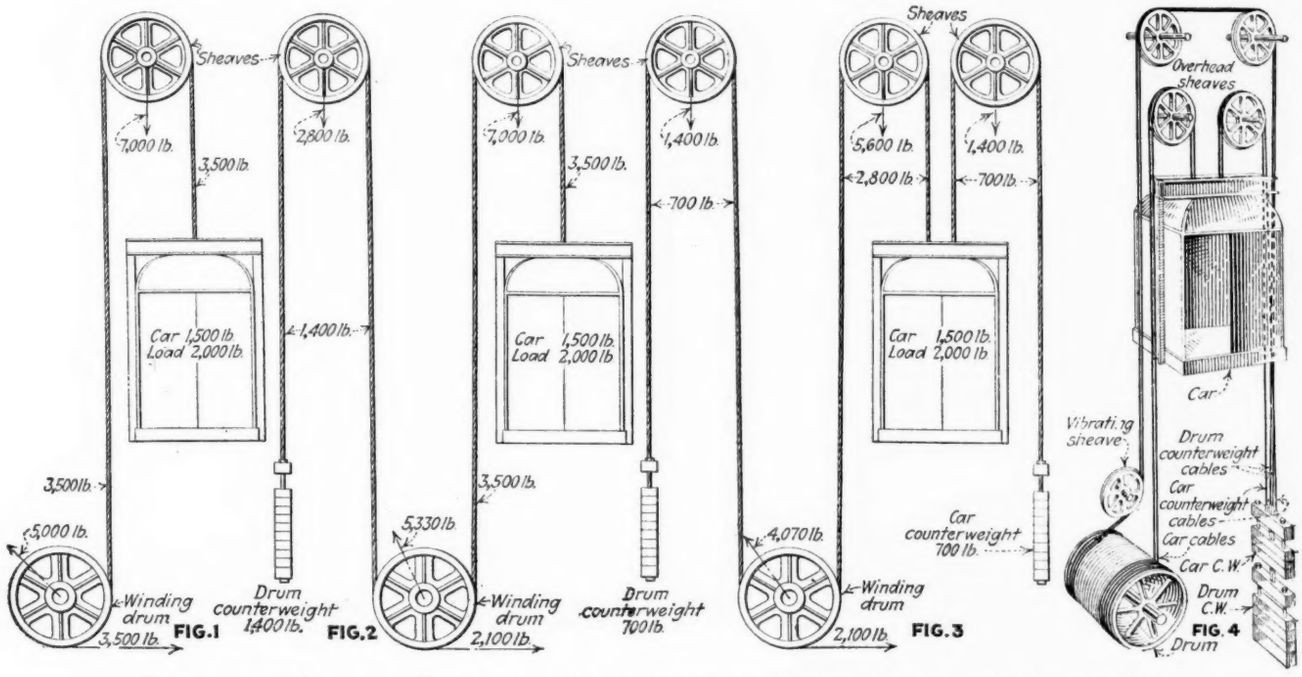
Throttling calorimeter .....98.6 per cent quality
Barrel Method .....98.5 per cent quality

Loading of Elevator Cables and Bearings

By CHARLES A. ARMSTRONG

How the Arrangement of Counterweights and Location of Elevator Machine Affect the Loading on Cables, Bearings and Overhead Work

THE simplest form of a winding drum-type of elevator machine is that shown diagrammatically in Fig. 1. This consists of a car of some kind connected by a cable to a winding drum. The drum is scored so that the cables will wind on in an even layer across its face. This drum may be driven by an electric motor through a worm gear, a spur gear or a without a load in the car and when fully loaded, especially in the down motion, makes this arrangement very unsatisfactory. Furthermore, in the up motion the motor must always be lifting at least the weight of the car, and in the down motion there will always be at least the weight of the car driving the motor as a generator and pumping back into the electric system,



Figs. 1 to 4—Show distribution of load on basement-type drum elevator machine and cables

combination of both, also in combination with one or more belts. The objection to this cable arangement is that the motor must be large enough to lift the total load including the weight of the car. The cables are subjected to the full load and the brakes must be strong enough to stop the total load in the down motion, including the weight of the car.

For example, if the car weighs 1,500 lb. and the rated load is 2,000 lb., then the motor would have to be of a rating capable for operating the machine when lifting 3,500 lb. The loading on the cable and overhead sheave would be as indicated. It will be noticed that the cables are subjected to a loading equivalent to the weight of the car and load and the overhead-sheave bearings are loaded to double this value plus the weight of the sheave. If the drum is driven by a worm and gear, the rear thrust bearing will always be subjected to a load equal to the weight of the car and its load. When stopping the car in the down motion, the loading on the thrust bearing will greatly exceed the weight of the car and its load.

The great difference between stopping the machine which results in an unnecessarily large power consumption.

The arrangement of roping shown in Fig. 2 overcomes some of the objections to the scheme in Fig. 1. Here a counterweight is used and its cables attached to one end of the drum and the car cables to the other. In the up motion the counterweight cables unwind and the car cables wind in the same grooves, whereas in the down motion the reverse action takes place. It is general practice to make the counterweight equal to about 40 per cent of the weight of the car and its rated load. Applying this rule to the car and load in Fig. 2 makes the weight of the counterweight equal to $3,500 \times 0.40 = 1,400$ lb., as indicated. With this arrangement the motor has to be large enough to lift a load equal to $3,500 - 1,400 = 2,100$ lb. This weight, 2,100 lb., is also the loading on the rear thrust bearing with full load in the car. Instead of the brake having to be large enough to stop and hold a load of 3,500 lb. when the car is in the down motion fully loaded, it need only be of sufficient capacity to take care of 2,100 lb. With no load in the car it is about balanced by the

counterweight so that very little power is required to move it in either direction. In the down motion with full load in the car, the motor will only have to resist a load of 2,100 lb. to prevent the machine from racing. All these conditions help to make the machine more efficient in power consumption.

Adding the counterweight has not, however, reduced the loading on the car cables, which is the same in both cases. On the other hand, the counterweight has increased the loading on the overhead beams 2,800 lb. plus the weight of the additional sheave, making it 7,000 + 2,800 = 9,800 lb. plus the weight of the sheaves. Another factor is that the loading on the drum-shaft bearings has been increased from about 5,000 to 5,330 lb. This, however, does not take into consideration the downward loading due to the weight of the drum or the upward thrust of the gear out of the worm. It will be noted that instead of the loading on the drum-shaft bearing being in a vertical direction, it is at an angle to the vertical, due to the combination effect of the vertical lift of the car and counterweight cables and the horizontal force transmitted from the worm and gear. The loading on the thrust bearing is based on the assumption that the worm gear is the same diameter as the drum. Where the gear is of a smaller diameter than the drum, the loading will be increased on the thrust bearing and on the drum-shaft bearings.

By using a second counterweight, called a car counterweight, as in Fig. 3, part of the weight of the car can be removed from the car cables and drum and the weight of the drum counterweights can be reduced, which will also remove part of the load from the drum-shaft bearings. By making the car counterweight equal to 700 lb. and reducing the drum counterweight 700 lb., then 1,400 lb. load would be taken off the drum shaft, besides removing 700 lb. load off the car-hoisting cables. The loading on the thrust bearings will remain the same as in Fig. 2, as will the size of the brake, but the load on the overhead work has been reduced from 9,800 to 8,400 lb. or a reduction of 1,400 lb. This reduction in weight on the overhead beams would be affected somewhat by the sheaves, but it is evident that the counterweight scheme, Fig. 3, has distinct advantage over the arrangements Figs. 1 and 2. It is for these reasons that the counterweights on drum-type elevators are arranged as in Fig. 3, although in practice the two sets of counterweights are generally arranged to run in the same guide rails, with the car counterweight above the drum counterweight, as in Fig. 4.

At first thought it might appear that placing the elevator machine overhead would cause a much heavier loading on the overhead beams than when the machine is located in the basement. Consideration of Fig. 5 will show that this is not necessarily so. For example, with the same load, weight of car and counterweights, the load on the overhead beams due to the car and counterweight is only 4,900 lb., in Fig. 5, as against 8,400 lb. plus the weight of the sheaves in Fig. 3, or a difference of 3,500 lb. plus the weight of the sheaves. So that, if the machine Fig. 6 weighed 3,500 lb., the loading on the overhead beam would be about the same in both cases. In some installations the loading on the overhead beams is less with the machine placed overhead than it would be with the machine in the basement.

Traction elevator machines are usually placed overhead as in Fig. 6. In the simplest type the cables pass from the car over the traction sheave and to the counterweight. On the traction sheave V-shaped grooves are used to provide sufficient traction between the cables and the sheave to prevent the cables from slipping. With full load in the car the maximum strain on the cables is equal to the load and the weight of the car, or in the figure, 2,000 + 1,500 = 3,500 lb. The loading on the sheave bearings is the combined weight of the car load and counterweight, or 4,900 lb. This is

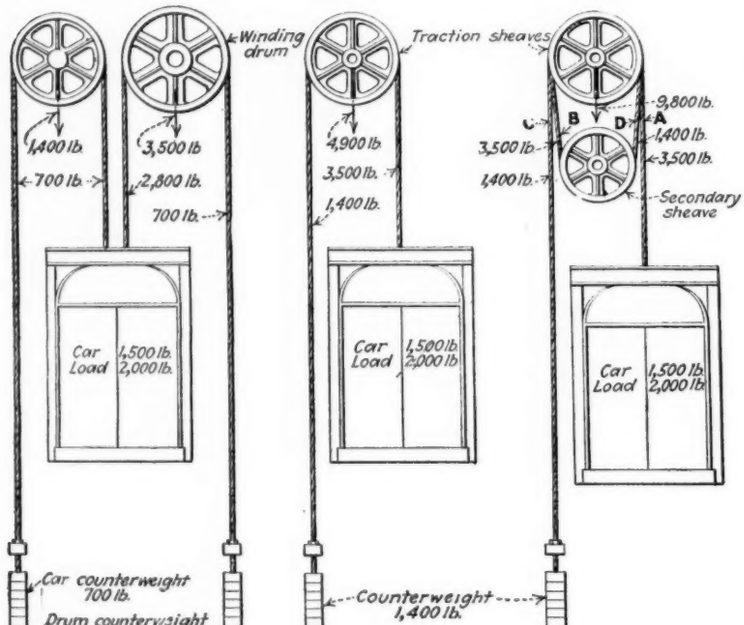
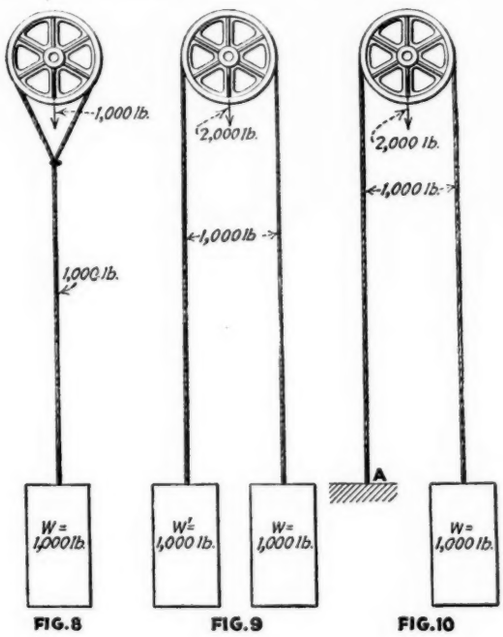


Fig. 5 to 7—Loadings on overload elevator installations



Figs. 8 to 10—Explains loading of the cables in a double-wrap traction machine

1,400 lb. more than on the drum-shaft bearings of a drum-type machine installed overhead.

The machine shown in the diagram, Fig. 6, is known as a V-groove or a half-wrap type. With the full-wrap machine, Fig. 7, the cables pass from the car over the traction sheave, down around the secondary sheave, back over the traction sheave and to the counterweight. Neglecting the weight of the additional sheave and extra weight in the machine, the load on the overhead beams in Fig. 7 is the same as in Fig. 6. However, the loading on the traction sheave bearings has been more than double. In Fig. 7, cable section *A* supports the car and its load. Cable section *B* may be considered as having a tension of 3,500 lb. Cable *C* sustains the load of the counterweight, 1,400 lb., and to put this load into equilibrium, cable *D* may be considered as supporting a load of 1,400 lb. This gives double the loading on the traction sheave that exists in Fig. 6. Although the friction between the cables and the sheave will affect the loading in cables sections *B* and *D* so that it may not be exactly as shown in the figure, an equivalent loading exists. Since the loading on the traction sheave in the double-wrap machine is double that for the single-wrap, for the same car load, the former must be constructed considerably heavier than the latter, and besides a secondary sheave is required, all of which tend to make the double-wrap machine considerably more expensive than the single-wrap type.

The reason for the loading on the double-wrap machine will be made clear by considering Figs. 8 to 10. If the load *W* is supported from the sheave in Fig. 8, then the sheave bearings must support a load of 1,000 lb. plus the weight of the sheave. This load of 1,000 lb. could be supported from the sheave by bringing the cable over the sheave and attaching a second load *W'* of 1,000 lb. The cable will have the same tension in it as in Fig. 8, but the loading on the sheave's bearings will be doubled. If, instead of attaching the cable to *W'*, it is dead ended as at *A*, Fig. 10, there will still be a tension of 1,000 lb. in each side of the cable, which will result in a load of 2,000 lb. on the sheave bearings, or double that in Fig. 8. What has been shown in Fig. 10 is very much the condition in Fig. 7, excepting that the counterweight and friction of the cables on the sheaves replace the dead end and the brake is applied to prevent the traction sheave from turning.

In the foregoing, to simplify the problem, all the factors that affect the loadings have not been considered, such as those forces that develop in starting and stopping, but those that have been taken account of are sufficient to indicate the advantages of one method of counterweighting or roping-up over another. Although all the various schemes of cabling up elevator machines have not been considered, the reader may work out the loading on any other arrangement by the simple process given.

Plant Inspection and Maintenance Schedule

By GEORGE E. GASTER

MANY power-plant executives apparently fail to appreciate the advantages that are to be obtained by an efficient inspection and maintenance schedule. The cost will be found a very small premium, when considered as a payment on insurance against failure of equipment at an inopportune time. When a defect is discovered and repaired, the cost of the attention will usually be much less than would be the expense after neglect has led to failure.

Keeping the packing of the valves, piston rods, shafts, etc., in proper repair means a decreased steam consumption. Clean turbine blades and proper blade clearance are necessary for efficient turbine operation, as well as are clean condenser tubes and an air-tight condenser.

The inspection and maintenance schedule, shown in Table I, which is the result of much thought and experience along this line, has been successfully applied in the steam division of a large power plant. It would probably be desirable to rearrange it for other stations, owing to different operating conditions and kind of equipment.

Boilers and economizers should be completely inspected every three months. Also, every time a boiler is cold an inspection should be made of the baffles, exterior surfaces of the tubes, furnace wall, stoker, soot blowers, feed-water regulator, gage glass and connections, all valves and fittings, and a report made in the usual manner.

In order to follow out the plan outlined, care was exercised in making out a daily schedule, so that the annual inspection of the main units came during the season of light load. At such a period, the supply and temperature of the condensing water insured a reasonably high vacuum on the remaining units, so that they could be depended on to carry full load. This condition could usually be expected during the months of April, May and June.

It seemed desirable in this plant to inspect and overhaul many auxiliaries, such as boiler-feed pumps and forced-draft fans on Sundays while the station load was light, because there was only one spare of each of these units. If, while the spare pump or fan, etc., was down for inspection, something should happen to one of the other units, the station would probably have to drop part of its load.

TABLE I—INSPECTION INTERVALS FOR THE STEAM DIVISION AND BUILDING

Name of Unit	Inspected at Intervals of
Steam turbines, main units	12 months
Auxiliary oil pumps	3 months
Circulating pumps and drive	6 months
Hotwell pumps and drive	6 months
Air pumps and drive	6 months
Air compressors	12 months
Fire pumps	3 months
Service water pumps and drive	6 months
Feed-water heaters	6 months
Force-draft fans and drive	6 months
Feed-water pumps and drive	3 months
Safety valves	1 week
Stoker drive	1 week
Coal-handling equipment	1 month
Locomotive cranes	3 months
Toilets, showers, etc.	3 months
Doors and windows	6 months
Roofs (supports and all building maintenance)	6 months

In determining the length of time between inspection periods on the different units, the following factors were considered: (1) Safety; (2) reliability of service; (3) inherent characteristics of the unit in regard to ruggedness; (4) demand for unit.

It will be noticed in Table I that boiler-feed pumps are inspected oftener than many other units. It is due to the fact that this type of service requires that they be absolutely reliable. The failure to get water into a boiler may not only result in an interruption of service,

..... Company
..... Plant

INSPECTION AND MAINTENANCE REPORT

Boiler No.....Out of Service.....In Service.....
Inspected by.....

Safety Valves	Stoker
Feed-Water Valves	Grates
Feed-Water Regulator	Dumping Mechanism
Blow-Down Valves	Side Wall Tuyers
Water Column and Connections	Rams and Ram Connections
Soot Blowers	External Parts
Dampers	Drive
Drums	Boiler Setting
Tubes	Baffles
Headers	Furnace Walls
Manholes	Brick Used
Hanholes	

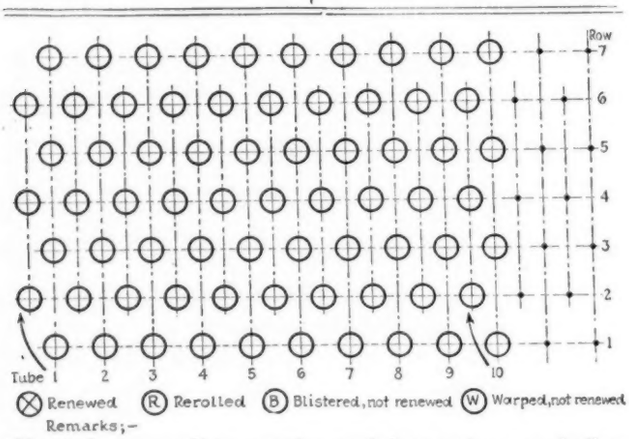


Chart for recording repairs and inspections on boilers

but it may also mean a boiler explosion with its resultant loss of life and property.

While condenser auxiliaries are, by reason of their construction, as liable to defects as boiler-feed pumps, yet if trouble should develop in one of these auxiliary units, it is not probable that it would be attended with the disastrous results that might be expected in the case of a boiler-feed pump. In most instances the main unit could still be operated, since condenser auxiliaries are usually installed in duplicate.

The small amount of work required to examine a boiler furnace, baffles, dampers, soot blowers, stoker, water column and connections, external surface of tubes, etc., every time a boiler is cold, will be liberally rewarded.

The semi-annual inspection of buildings is best made in autumn and spring. In the autumn, the doors, windows, etc., can be prepared for winter, while in the early spring a close inspection will disclose any damage to roofs and building walls by freezing and repairs can be made at once, so as to prevent further damage.

In order to insure that all work will be done at the proper time, it will be found advisable to make out a schedule covering every week of the year. During the first year it may be found that more work has been scheduled for certain weeks than can be completed with the help available. By rearranging this schedule day by day as inspection and maintenance work the first year is followed up, a valuable schedule that can be closely followed in the future, will be obtained.

The schedule as in Table II, covering the work to be done by the turbine-room maintenance department during the four weeks of April, serves to illustrate how this schedule may be arranged. The same system is followed out in the other departments.

A clerk has charge of making out the weekly schedule. These are made out in triplicate, one copy to remain in the office, one for the chief engineer and the third copy, after being signed by the chief engineer, is for the men in charge of the maintenance work in each department. If there is any work scheduled for a certain week, which cannot be completed, it is carried out as soon as possible thereafter.

When a man in charge of the maintenance in a certain department has completed the work outlined on

TABLE II—INSPECTION AND MAINTENANCE SCHEDULE FOR APRIL IN THE TURBINE-ROOM MAINTENANCE DEPARTMENT

First Week	Third Week
No. 1 boiler-feed pump.	No. 2 boiler-feed pump.
No. 1 boiler-feed pump turbine.	No. 2 boiler-feed pump.
No. 4A circulating pump.	No. 1 forced-draft fan.
No. 4A circulating pump turbine.	No. 2 air compressor.
No. 1 air pump.	No. 2B hotwell pump.
Second Week	**Fourth Week**
No. 1 main unit.	No. 2 main unit.
Coal handling equipment.	No. 1 locomotive crane.
No. 2 auxiliary oil pump.	No. 2B. circulating pump.
No. 1A hotwell pump.	No. 3 auxiliary oil pump.
No. 1A hotwell pump turbine.	

one sheet, he checks it off and returns it to the office, together with a report on the condition of the apparatus and the repair work done. The report is examined by the chief engineer and passed on to the clerk to be filed.

In the office there is a file case on inspection and maintenance which contains a file on each unit or piece of apparatus in the plant. Each time a unit is inspected or repaired, a typewritten report is made and filed therein.

Owing to the large number of detailed repairs required by a steam boiler installation, and in order to decrease clerical work and to make more useful reports, a printed report blank shown in the figure is used in keeping records of boiler inspections and repairs.

On the Chicago, Milwaukee & St. Paul Ry. between Harlowton, Mont., and Avery, Idaho, and between Othello and Tacoma, Wash., there are 848 miles of electrified line. The first operation was started in November, 1916, and the latter in March, 1920. A recent report issued by the railway company shows a total net saving from electrical operation over steam, up to the end of 1924, of $12,400,007. Power is purchased along the railway line at three-phase 100,000 volts and transmitted to substations, where it is stepped down to 2,300 volts and converted into 3,000-volt direct current for use in electric locomotives

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In the case of joining two metal sheets by means of the electric-arc weld, one method of handling the expansion of the metal in the plates is to put in short sections of weld at intervals, welding in one layer at a time, starting at the center and working alternately toward either end, then to put one layer in the open sections and continue in the same way until the weld is completed. The welded section of any layer should not match those in the layer above or below it, but the joints should be broken in the same manner as the laying of brickwork.

Taking That Bark Out of the Exhaust

Why One Oil Engine Has a Noisy Exhaust While Another Operates Smoothly—Effect of Poor Exhaust Connections on Engine Performance—Means of Making Exhaust Quiet

BY HIRAM PERCY MAXIM

A SERIOUS handicap confronting the manufacturer and the user of oil engines is the objectionable noise made by the exhaust. As a consequence, it is by no means seldom that a complaint develops into a court action whereby some adjoining property owner cites the oil-engine owner as maintaining a nuisance, in that for blocks around the plant the sleep of dwellers is broken by the machine-gun bark of the engine. Fortunately, the difficulty is easily remedied by an inexpensive alteration in the exhaust connections.

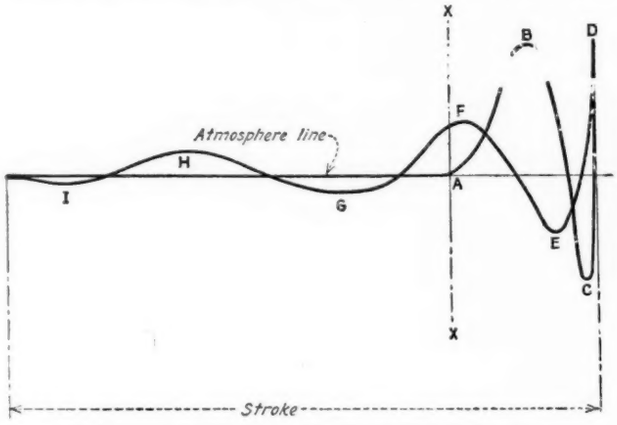


Fig. 1—Pressure waves in exhaust line

In providing for the exhaust of large oil-engine installations, it has been thought that all that was necessary was to provide a large expansion chamber so that the exhaust gases would be given an opportunity to expand quickly. The idea quite generally prevails that the expansion of the gases in a large chamber lowers the back pressure and muffles the exhaust noise. This can be a very wrong idea, and it can be the cause of much trouble and unnecessary expense.

The two causes for the wrong impression mentioned come from the failure to realize that a large exhaust conductor and expansion space does not always mean low back pressure, and the failure to realize that noise is one thing and gas flow another very different thing. I have been called upon many times to advise owners of power plants how best to get over exhaust difficulties and I have seen tremendous sums of money thrown away because of the failure to grasp the two points mentioned. For example, a six-cylinder oil engine of 300 hp. had been installed in a certain plant, and the engine performance had not been entirely satisfactory on account of back pressure. In addition the noise of the exhaust could be heard for a mile away from the plant. The exhaust system consisted of a large exhaust pot, giving quick expansion and a 60-ft. exhaust stack.

When operating conditions became so bad that something had to be done, a concrete pit was built at considerable expense to connect the exhaust pot with the stack. To the astonishment of the owners this change made the engine operate much worse and considerably increased the noise.

From the history of the case it was evident that the "patient" was suffering from an acute case of bad tuning and resonance. The bad tuning resulted from the accidental dimensions that happened to be established for the concrete pit, which just chanced to be right for bringing the high-pressure point of an exhaust wave at the instant the exhaust ports closed. This gave back pressure and bad engine performance, notwithstanding the increased size of the exhaust system. The resonance, whereby the noise of the exhaust was amplified, was probably due to the same thing that causes the amplifying of the noise of the Fourth of July firecracker when it is exploded in the barrel.

To get a grasp of what was going on in that concrete pit, it is necessary to understand what happens in the exhaust of an oil engine. It happened that the particular installation in question was a two-stroke-cycle engine. An indicator diagram taken of the pressure variations in the exhaust pot, which was connected to the concrete pit, appears in Fig. 1. The exhaust port opens at line *XX*, and the pressure rise resulting from the release of the exhaust gases from the cylinder starts at *A* and rises to *B*, and proceeds to oscillate from there on. It will be noticed, first of all, that the pressure is oscillatory in character. That is to say, there is a wave motion and there are points where at a certain instant the pressure is above atmosphere and there are other points where the pressure is below atmosphere.

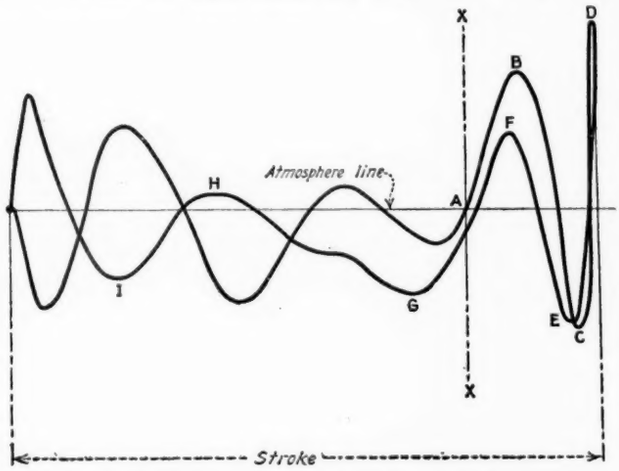


Fig. 2—Change of connections improved pressure conditions

It will be seen from an examination of Fig. 1 that the exhaust port closed at *F*, one of the points of high pressure in the exhaust system. It is apparent that the frequency of the waves is a measurable quantity. From this, it follows that if some kind of tuning, or control

of frequency, could be secured, we would be able to make the low point of a pressure wave coincide with the closing of the exhaust port. This would give very good engine performance, for the reason that the scavenging would be good.

In order to understand this phenomenon of tuning, it might pay to consider this curious tendency of oscillate. Any sudden release from a high pressure seems to be oscillatory in character whether the energy released is gaseous, liquid or electric. If the resistance in the conductor through which the discharge occurs is high, the oscillations are quickly damped out. The tendency that creates the oscillation is the tendency

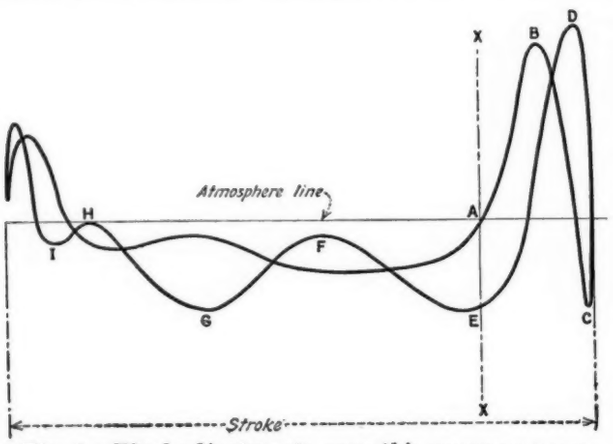


Fig. 3—Final adjustments gave this pressure curve

to overdischarge, or overswing. The pendulum, when released, overswings. When it swings back, it overswings back. This continued overswinging we call "oscillating." Unless we understand exactly what is going on, these oscillations are likely to cause much trouble. On the other hand, when we understand them, we are able to make them assist us. This is what is called "tuning." As the diagrams show, it is perfectly simple to indicate the high points and the low points in the oscillations. It is therefore apparent that it is desirable to control them so that we can make a low point coincide with the closing of an exhaust port. To carry the matter to the field of suctions, it can be seen that it is possible to make a high point coincide with the closing of an intake port.

Indicator Shows Pressure Waves

In Fig. 1 the exhaust pressure being released at *A*, *B* shows a high point, *C* a low point, *D* the next high point, and *E*, *F*, *G*, *H* and *I* alternating low and high points. It is apparent that the high point *F* practically coincided with the closing of the exhaust port. This gave high temperature exhaust readings, a sure sign of back pressure and poor engine performance.

Turning to Fig. 2, where a change was made, we have the same pressure release at *A*, a high point at *B*, a low point at *C*, a high point at *D*, a low point at *E*, but the high point at *F* has been brought forward and the exhaust port has not yet closed. The pressure wave has fallen to approximately atmosphere at the instant of closing of the exhaust port. The engine performance was better.

More of the same thing gave the diagram shown at Fig. 3. The pressure is released at *A*, *B* is a high point, *C* a low point, *D* a high point, and this time the low point *E* is made to coincide approximately with the closing of the exhaust port. Splendid engine performance immediately resulted.

The means by which we are able to control just where a high pressure and a low pressure shall come is to change the capacity of the exhaust system, or to change its length. It is possible to place an adjustment either in an intake system or an exhaust system, which will alter wave lengths, or frequency of the oscillations, so that the right combination for best performance can be secured. In a very rough way, it is not unlike the tuning of a radio set to suit the different frequencies or wave lengths of different broadcasting stations.

Thus we see how ill luck can bring about just exactly the combination of dimensions in a concrete pit to give the highest point in an exhaust wave, at the instant that the exhaust ports close. To correct this a radical change is usually necessary in the concrete pit or expansion tanks, which may be very expensive, and with grave doubts as to the efficiency of the arrangement.

Turning to the other difficulty, that of noisy exhaust, why was it that the introduction of the large concrete pit increased the exhaust noise? The answer is: For the same reason that the announcer at a football game transforms his voice into the voice of a superman by making use of an expansion chamber known as a megaphone.

The reason that the megaphone amplified the announcer's voice, was because it set into oscillation a larger weight of air before liberation into the surrounding atmosphere. It is a complicated matter to explain, but it has so many every-day examples that we are able to grasp. We call it "resonance," and when we place the tuning fork on the cigar box or the violin bridge on the thin wooden box that we call the body of the violin, we make use of it. The trouble is that we forget it when we install an oil-engine exhaust system, and the first thing we know, we are doing what corresponds to putting a megaphone on the exhaust to amplify it, instead of silence it.

What Constitutes a Noise

The noise wave is a zone of compressed air followed by a zone of rarefied air, and it is one of nature's laws that such a wave spreads out in all directions at a constant velocity of approximately 1,100 ft. per sec. It continues to spread out until attenuation finally makes it inaudible to the human ear, the air offering almost no resistance.

The gas flow, on the other hand, is subject to entirely different laws. At the very beginning of the burst of the column of exhaust gases into the atmosphere, it has a velocity many times that of the sound wave, and yet before the gases have advanced any substantial distance, they have been checked, distorted, and offered every kind of a resistance by the stationary air, until their velocity is considerably below that of the sound wave.

The gas flow itself does not create the noise that we call a "bark." If it is given a chance to flow smoothly without turbulence, it is almost quiet at moderate velocities. Only when it is compelled to assume high velocities or pass across sharp corners does it develop a noise that is offensive. Therefore, it is the original noise wave with which we must deal, when we undertake to silence an oil-engine exhaust.

This silencing must be done either by transforming the energy represented by the sound wave into some other form, such as heat, or by subdividing it so that it reaches the listening ear in small doses.

Heating, Cooling and Ventilating System for Office Building

By J. S. MOULTON
Assistant to Executive Engineer, San Joaquin Light & Power Corporation

THE new office building of the San Joaquin Light & Power Corporation, at Fresno, Calif., shown in Fig. 1, contains an elaborate system for heating, cooling and ventilating, to provide comfortable working conditions through the wide range of temperature and humidity occurring in San Joaquin Valley.

Of the ten stories, the first is used as a lobby, consumers' counter and display room for electric merchandise and equipment. The second to ninth floors house the Fresno district and all the general offices of the company. The tenth floor is utilized as an auditorium and library. A completely equipped electrical kitchen is available for serving banquets which may be held in the auditorium. A closed system of ventilation is employed utilizing ducts and exhaust fans for various portions of the building. These fans make it possible to keep all windows closed, thus eliminating annoying drafts and dust deposits which accompany open windows. Either partial or entire recirculation of the air may be utilized.

Fig. 1—Air cooling is equally as important as heating in this building

The tenth floor of the building, devoted to the library and auditorium, is not used to any great extent during the daytime. For this reason an entirely separate system of ventilation is provided for this floor so as to eliminate the expense of operating the main building system in the evening when otherwise it would not be needed.

A common intake for the rest of the building is provided, but three separate fans are used for supplying respectively the basement, the first floor and the office space proper. The last-named consists of the second to the ninth floors inclusive. A group of three exhaust fans remove the air from the same spaces. All fans with the exception of the basement supply and exhaust are driven by variable-speed alternating-current motors and are arranged to supply practically twice as much air during the cooling period in the summer as is supplied during the winter.

This provision is made, as the quantity of air required for ventilation alone is not sufficient to counteract the radiation and convection through the walls from the outside air in the summer. The main building fans are capable of supplying or exhausting up to 70,000 cu.ft. of air per minute, which makes possible a total change of air every eight or ten minutes throughout the office.

A duplicate set of ducts are provided for the first floor and auditorium systems, as the building construction did not lend itself to the sealing off of spaces for the exhaust. As the double set of ducts was necessary, a turntable valve was installed to make a reversal of floor heating and cooling possible. Thus in the summer the cooled air is introduced at or near the floor and the accumulated warm air removed from near the ceiling. In the winter the reversing of this valve allows the introduction of the supply air, now warmed at the ceiling, and the removal of the cool air which collects at the floor.

A complete duplicate set of ducts for the main building would have involved not only the cost of this second set, but the much greater cost of making the space between the ceiling and floor above for each of of the eight floors served from eighteen inches to two feet higher.

Dampers are installed between the intake and exhaust ducts of the first floor and the main building system to make possible a partial or complete recirculation of the air. This feature is of particular value in the winter when the use of ozone for purifying the air makes it possible to recirculate almost completely at night and when the building is sparsely populated, and to a lesser extent during the day. A considerable saving in fuel for heating is thereby made.

Both the main and the auditorium systems contain

ozonating equipment so as to assure a supply of absolutely fresh air. While there are no foodstuffs in the building except when an occasional banquet is held in the auditorium, it was believed that there would still be sufficient odors to make the oxidizing power of the free ozone useful. These ozone machines have not been used continuously, and sufficient data have not been obtained on their operation to make reasonable conclusions as to their usefulness.

Refrigeration is necessary during part of the summer months to provide adequate cooling without excessive increase in relative humidity. The water for use in the four air washers may either be taken directly from the city mains or can be chilled by passing over ammonia expansion coils supplied by two 50-ton refrigerating compressors. When these washers were first installed, one was not arranged to use chilled water, it being thought the remaining washers would tax the capacity of the refrigerating plant in holding the water down to 40 deg. F. temperature.

After the washers had been operated for some time, it was found that better results could be obtained by using chilled water through all the washers, even though this practice resulted in raising the temperature of this water as high as 50 deg. This still represented a reduction of more than 20 deg. in the water as taken from the city supply.

No Direct Radiation on First Floor

During the winter the washers may be used if desired to remove impurities from the air, although, generally speaking, atmospheric conditions are such that this is hardly considered necessary. A set of heating-coil sections were placed in the air intake for the main building ahead of the air washers to temper the incoming air. Other sections installed between the washers and the supply fans raise the incoming air temperature to that existing within the building.

The set for the first floor is of sufficient size to make auxiliary heating by direct radiation on this floor unnecessary. The greater radiation losses for the rest of the building make it more economical to use direct radiation in the various offices than to attempt to do all the heating by means of the ventilating system.

The heating coils in the air supply for the first floor are controlled by thermostats in the lobby, which can be set to hold any desired temperature on this floor. The heating coils for the main portion of the building are controlled by a thermostat on the discharge side of the supply fan. This thermostat is set at 64 to 65 deg. F., which has been found the most satisfactory temperature for the supply air. The exposure of a portion of the building walls to the sun often raises the temperature in the adjacent offices to around 68 without the use of auxiliary steam, while other portions of the building require its use. It was found that the supply air could not be carried at a higher temperature without making some of the offices uncomfortably warm.

The auxiliary radiators in the various offices are all equipped with individual hand control valves. The expense of thermostats for controlling the temperature during the comparatively short winter season was not considered justified, it being thought the occupants of each office could operate these valves to maintain the temperature as individually desired. This part of the system has not proved entirely satisfactory, and the author now believes that the added expense of thermostats on these radiators or at least on the major portion of them would have been fully justified.

The system as a whole has been extremely satisfactory in its operation, making the working conditions, particularly in the summer, much better than could possibly be obtained without the cooling system.

Fig. 2 shows the cooling which is obtained during the extremely hot summer weather with the system. The four days shown were plotted from the records of the warmest weather during the first part of the summer and show that as much as 25 deg. reduction in dry-bulb temperature was obtained by the air washers.

The record (dotted line at upper right), taken from a thermometer in one of the offices shows over a two-day period the temperature variations in the working space. The effect of the thermal capacity of the building is quite noticeable on this curve, as it is much more uniform than either the outside or the cooled air temperatures as measured in the basement.

It has been found by experiment that the humidity

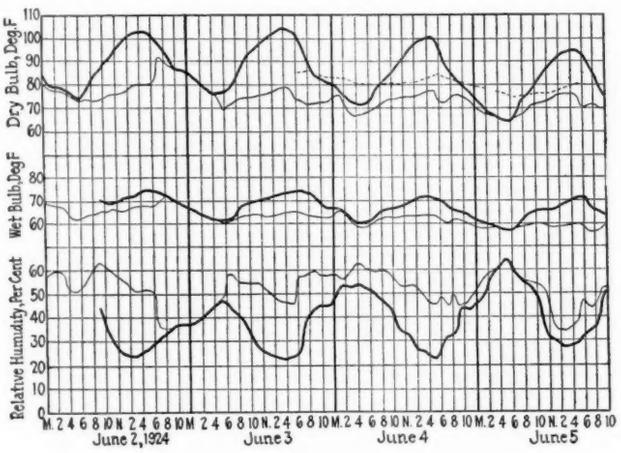


Fig. 2—Comfortable conditions maintained in hot weather

Curves plotted from engine room log sheets. Heavy line shows air conditions in intake before cooling and light line after passing through air washers. Dotted line at upper right represents conditions in a room on the ninth floor.

in the building will be at least 5 per cent lower than that measured in the basement. Also, a relative humidity in the office of from 40 to 45 per cent with a dry-bulb temperature of 80 deg. is very comfortable. Instructions have therefore been issued that the humidity after cooling in the basement shall be kept below 50 per cent at all times.

The total power used in the building is metered and billed to building operating cost according to published schedules applying to similar load furnished any consumer. During the six months from April to September inclusive, this average rate has been 1.188 cents per kilowatt-hour. The ventilating fans for the main building during this period have used 64,040 kw.-hr., which at this rate would cost $760. The cost for a twelve months' period will be less than twice this amount, as the fans will be operated at lower speed during the winter months. During the same period the refrigerating machines used, in conjunction with the cooling system of the entire building, 67,320 kw.-hr., costing $798, or $4.35 a day. Reference to the graphs of cooling accomplished should not leave a doubt in anyone's mind that this cost is repaid many times over in increased morale and efficiency of the 350 employees in the building.

Belgian Engineer Develops Internal-Combustion Boiler

Oil Flame Burns Under Water—Air and Oil Supplied at Boiler Pressure—Inventor Claims Extraordinary Efficiencies—Combustion Products Pass to Engine with Steam

Photo by International News Reel
Oscar Brunler

THE idea of burning fuel directly in contact with the water of a boiler is by no means new, but in spite of the fact that previous attempts have not resulted in commercial success, the idea will not stay down. The latest experiments along this line have been made by Oscar Brunler, a Belgian engineer, who presented a paper describing his apparatus before a joint meeting of the Institution of Chemical Engineers and the Chemical Engineering Group of the Society of Chemical Industry, at the Institution of Mechanical Engineers, in London, on Feb. 11.

According to Mr. Brunler the first internal-combustion boiler that would operate continuously was made fourteen years ago. This, he said, was not a commercial proposition and two more years passed before the boiler had reached a stage where it could be guaranteed to work for months without breaking down. At the outbreak of the war orders had been placed for about twenty of these boilers in various industries, but destruction of the factory in Belgium when the war broke out prevented the carrying out of these orders. The work had been going on under the leadership of the father of the present Brunler. On the death of the father, at about this time, the son carried on the work. He stated in his paper that it was in 1922 when he succeeded in building a boiler that worked continuously for months.

The following paragraphs are a digest of certain portions of Mr. Brunler's paper.

All designs of boilers are based on the principle of bringing the flame of the fuel in the closest possible contact with the water in the boiler. Why not burn a flame in immediate contact with a liquid? This is easily accomplished, as is shown by the working of the internal-combustion boiler, the principle of which is to maintain a flame burning in the liquid in order to evaporate the latter. During the years of experimenting, liquid hydrocarbons of specific gravities ranging from 0.8 to 1.2 have been used. More than sixty different kinds of oil from many countries have been tried, and all these could be burned without difficulty. Figs. 1 and 2 show the complete apparatus, consisting of a central steam and water storage drum connected to several steam generators. One of the latter is shown in section in Fig. 2.

The fuel oil and the air necessary for combustion are supplied to the burner under a pressure that barely exceeds that of the steam. Before starting, the connection valve is closed, and the water level in the generator must not be above the lower mouth of the burner. The cover of the ignition lamp is removed after heating the fireclay lining of the ignition lamp; the oil and air ignite on the fireclay lining. Then the cover is pulled down again, and the flame of the ignition lamp makes its way to the burner. After a few minutes the main burner is hot enough whereupon the main regulating valve is opened and the flame burns in the generator.

Now the connecting valve to the water reservoir is opened and the water in the generator rises up to the middle of the burner. The flame, which burns quietly in the water, can be observed through the peep-holes in the generator.

By means of the superheater the steam can be superheated to any required degree. The superheater consists of a small burner similar to the ignition lamp, and its flame burns in the steam reservoir. The size of the flame and consequently the quantity of steam is regulated by means of the regulating valve; at the same time the ratio of oil and air is kept constant. By turning one wheel, the size of the flame can be regu-

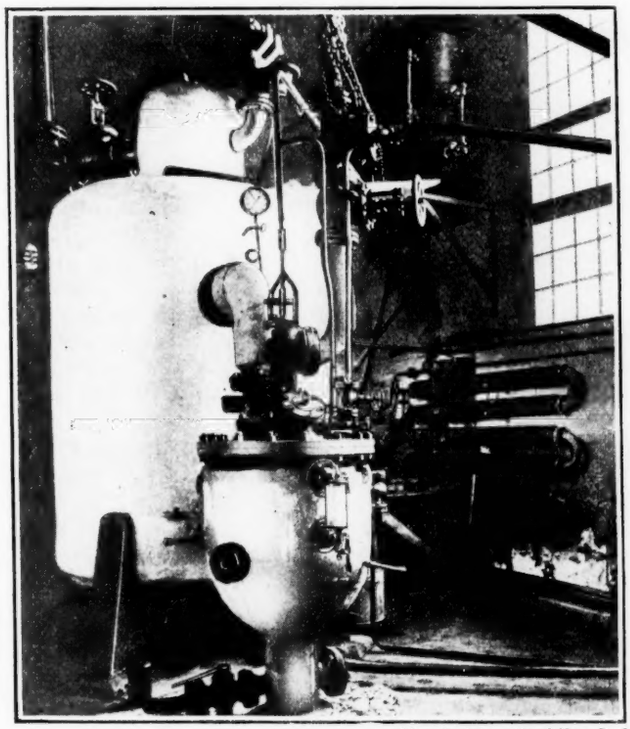


Photo by International News Reel

Fig. 1—Oscar Brunler's internal-combustion boiler

lated, without changing the ratio of fuel and air. Therefore it is not possible that the combustion can be altered through mistakes of the stoker.

The temperature in the center of the flame is approximately 3,300 deg. F. This temperature diminishes to the periphery of the flame, so that between the center of the flame and the periphery a rapid fall of temperature takes place. Since a permanent stream of burning gas has to pass this fall of temperature, it is evident that the last traces of carbon-monoxide must be converted[1] into carbon dioxide.

[Here Mr. Brunler went on to compare the working of his complete plant with that of an oil or gas engine. Admitting that the Brunler outfit required a compressor to deliver the combustion air against boiler pressure, he pointed out that the oil engine likewise had to compress its air. The substance expanded in the engine with the Brunler outfit was a mixture of nitrogen, carbon dioxide and steam. The same substances were present during the expansion stroke of oil engines, though in different proportions. These comparisons were aparently drawn to give the impression that the Brunler plant was theoretically equivalent to an oil engine. In comparison with an ordinary steam plant, the impossibility of operating the Brunler plant condensing was admitted, but it was claimed that high efficiencies were obtainable in spite of this limitation.—Editor.]

In practice we have obtained, in certain cases, more than 100 per cent efficiency; consequently, there must be either a slip in the experiments or in the determination of the calorimetric value. All the experiments have been carried out so carefully that there must be a missing factor in our present formulas. There must be some kind of latent energy that is set free during combustion which we cannot utilize at the present time. So far there is no way to analyze this.

I am of the opinion that under certain conditions, which are still unknown to us, electric vibrations produced during the combustion are converted into useful energy, and thus a higher efficiency than 100 per cent is obtained. During the tests that have been carried out with the submerged flame, evaporations have been obtained that surpass the theoretical ones. Samples of the oils used during the tests were chemically analyzed and burned in the calorimeter and the exact calorimetric value of the oil was determined, but for weeks and weeks a higher calorimetric value and consequently a higher efficiency than 100 per cent was obtained in the generator.

I shall mention a few out of the many striking experiments where a higher calorific value or a greater efficiency than the theoretical was obtained.

Hausser made the observation during his experiments to manufacture nitrates, that sometimes efficiencies were obtained that surpassed the theoretical output by 90 to 120 per cent. He also exploded gases in bombs of different sizes and found that with bombs of different sizes different results were obtained.

Similar observations were made by Haber and Koenig in experimenting with electric arcs to manufacture nitric oxide.

Hahn obtained a calorific value 10 to 12 per cent higher than the theoretical calorific value of the fuel in passing a stream of steam into the oil flame.

A good many more reports of this kind can be found in the technical literature.

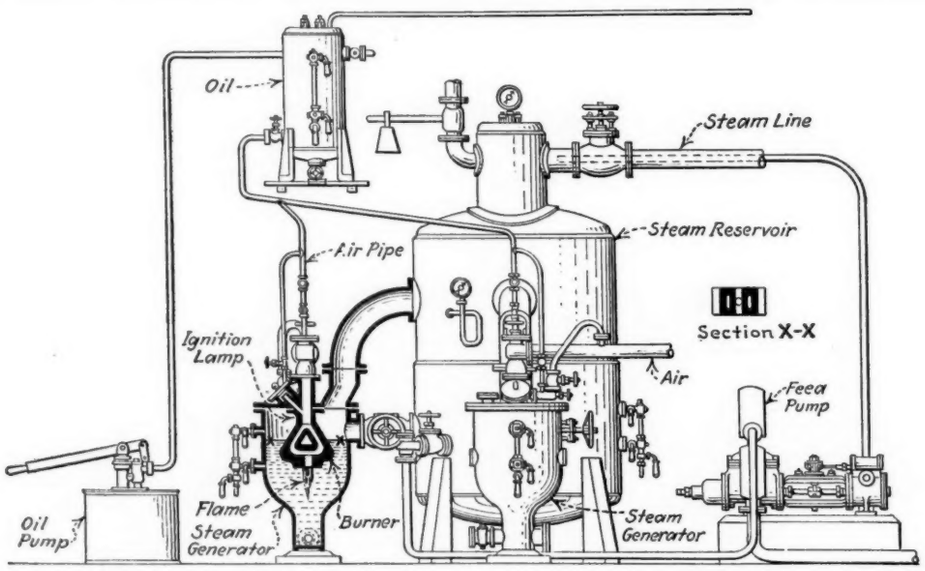


Fig. 2—Elevation of complete apparatus showing one steam generator in cross-section

The relative central-station capacities serving London, Paris and Berlin, according to *World Power*, are respectively 675,000 kw. in 85 stations, 770,000 kw. in 8 stations and 213,000 kw. in 7 stations. The annual output per capita in London 163 kw.-hr., Paris 430 kw.-hr., Berlin 320 kw.-hr.

[1]It should be noted that this and the later claim of efficiencies exceeding 100 per cent are merely reports of Mr. Brunler's statements and do not represent the opinion of the editor. Further comment will be found on the editorial pages.

One Pound Per Horsepower

POWER equipment weight varies widely according to its type and speed. Increased ratings of boilers and speed of prime movers have resulted in great reductions in size and weight per unit of power capacity in steam plants, but even with all modern improvements the weight per horsepower capacity is still high and extremely variable when the weight of all equipment and the water in the boilers and condensers are included.

The only possibilities of obtaining extremely light weight in fuel-consuming plants is with internal-combustion engines. In this type of plant the weight varies from the Diesel of two to three hundred pounds per horsepower to near one pound per horsepower for the latest airplane engine. This latter value has been very closely approached in the two new types of army and navy airplane engines recently reported as having been produced in this country. These engines are rated at five hundred and eight hundred horsepower, having a speed of two thousand revolutions per minute and developing one horsepower for each 1.04 pounds of motor weight. The previous record in this country was held by the engines used in some of the racing planes with a weight of 1.3 pounds per horsepower.

It is interesting to contrast the weight of these highly refined engines, with their extremely low weight, with the horse. It is estimated that a twelve-hundred pound horse can develop about one horsepower for eight hours, hence thirty-six hundred pounds is required to produce one horsepower continuously. Evidently, the man-made device is a big improvement over the natural and far more easily applied in most cases, although the life of the high-speed airplane engine is seldom much over one hundred hours without overhauling.

What Is Smoke?

IS SMOKE everything that goes up the stack; is it merely the black material visible at a distance; or does the word smoke include all stack products that are harmful to health, property or landscape?

In Pittsburgh, where laundries and dry-cleaning establishments still do a rushing business, a smoke survey was made in 1912-13 by the Mellon Institute. As a result a smoke ordinance was drawn up restricting the production of No. 3 (Ringlemann Chart) smoke to a total of two minutes or more in any period of fifteen minutes. This was modified to one minute in eight for locomotives and steamboats, while private dwellings and small apartment houses were exempted altogether. A permit was required from the Bureau of Smoke Regulation before any major work could be done on a chimney or piece of combustion equipment. All new installations were required to be capable of operation within the rules.

As the net results of this effort the visible smoke in Pittsburgh has been reduced about 80 per cent. Yet the astounding fact remains that the total solid material emitted from the stacks increased from 85 tons per square mile per month in 1912 to 119 tons in 1924. This was shown by a test made by the Mellon Institute covering the period from August, 1923, to June, 1924. Of this total only one-fifth of a ton was tar, other combustibles amounting to forty-two tons, ash fifty-one tons and iron oxide twenty-six tons. Apparently, the tar was the chief cause of the visible smoke, since this was the only item that showed a decrease since 1912.

Aside from the normal growth in coal consumption, it is probable that some of the very measures taken to comply with smoke ordinances have increased the total discharge of solids into the atmosphere. For example, forced draft generally reduces the visible smoke, but may greatly increase the amount of cinders and small particles carried to the atmosphere.

Consideration should be given to the suggestion made by H. B. Meller, Chief of Pittsburgh's Bureau of Smoke Prevention, that the war against smoke be extended to include all solid matter leaving the stack.

Inexpensive Service Accounting

IN THE majority of hotel, office-building and even factory power plants systems of crediting the power plant with the services rendered to the different departments do not exist. For example, the cost of heating the building is lumped with the cost of generating power and totalled as being the power-plant cost.

Inquiries usually bring an answer that it is impossible to determine the amount of steam supplied the system and that it is as a consequence impossible to ascertain the heating cost.

The management should realize that such slipshod accounting methods would not be tolerated even as to the stamp account. This practice practically invites the engineer to give no heed to wastes.

In addition the practice mentioned by ignoring the heating, saddles the generating end with an exorbitant expense. It prevents the officials from judging the comparative advantages of purchased and generated power.

While it is true that flow meters are expensive, the investment of a thousand dollars might be justified if the resulting saving were only two hundred dollars a year. It is worth far more than this to be able to compute the actual cost of the power generated.

In place of steam-flow meters a condensate meter will give the amount of steam supplied the heating system. It is easy to deduct from the total heat leaving the boiler the net amount of heat converted into power as long as there is no atmosphere exhaust. If part is lost to the atmosphere, it must be compensated for by the raw makeup water. If the makeup be measured

through a cheap water meter, the amounts of steam supplied to the heating lines and to the engine can be determined with a fair accuracy. In other words, expensive instruments are necessary for close calculations, but for approximate results cheap makeshift methods work quite satisfactorily. An engineer who confesses he cannot determine the proportioning of the cost of the power plant at once acknowledges his own inefficiency.

The Internal-Combustion Boiler

WHILE Oscar Brunler's internal-combustion boiler, described on page 379, represents the application of an idea that is by no means new, the description of his accomplishments will be of great interest to engineers. The operation is made fairly clear in the condensed report. Neither this nor the original paper on which it is based, however, is completely convincing on the practical application of this device. The necessity of compressing to more than full boiler pressure all the combustion air required seems to be a serious drawback. Of course it must be remembered, as pointed out by Mr. Brunler, that this correspondingly increases the amount of products that may be withdrawn from the boiler for use in an engine, but to compress air with a steam-driven compressor and then use that same air to produce work in a cylinder would seem to incur a triple loss whose total might be serious.

On the other hand, flue losses are evidently eliminated, which would lead one to expect a very high boiler efficiency. This expectation is not disappointed. In fact, Mr. Brunler insists that the efficiency obtained, based on reliable calorimetric measurements, runs continuously over one hundred per cent. This claim will undoubtedly be greeted with the greatest skepticism, which will not be decreased by Mr. Brunler's suggestion that some unknown electrical forces may exist to make up the difference between the heat he obtained in the generator and what he supposed to be in the oil. It is dangerous to make fun of any idea these days, but Mr. Brunler should not be surprised if engineers demand further proof of his efficiency claims.

From the practical point of view the over-all results (in pounds of oil per net horsepower) obtained with an actual self-contained plant, consisting of generator, engine, oil pump and compressor, would be of great interest.

Something More Than Cheap Power Needed

POWER, particularly that developed from waterfalls, seems to create an impression with those not familiar with the facts, that by some magic it is capable of producing almost everything. If water power is available, then the country's industrial development is assured, irrespective of what else may be needed to make these industries possible, is a common attitude. However, processes that a few years ago depended upon a source of cheap power to make them successful, are today more dependent upon cheap fuel and other raw materials. Probably one of the best examples of this is the fixation of atmospheric nitrogen. With the electric-arc process, which was the first, about sixty-seven thousand kilowatt-hours were required per ton of nitrogen fixed, where with the more recently developed synthetic-ammonia process only about four thousand kilowatt-hours are required per ton.

John R. Freeman, speaking before the Annual Convention of the American Society of Mechanical Engineers in December, 1923, on "The Principles Underlying Hydro-Electric Development," said: "There is a widespread popular misunderstanding about the present demand for water power. Many think there are great chemical industries earnestly seeking hydro-electric power. The chemical engineer of large vision is today looking for cheap B.t.u. far more than for cheap kilowatt-hours." This statement would seem to be further emphasized by the recent announcement that the Carillion development on the Ottawa River in Canada was being held up awaiting a satisfactory export license to transmit power into the United States. This project, which involves some three hundred thousand horsepower and a fifty-million-dollar investment, it would appear cannot be made at this time unless there are some assurances of markets for the power other than those that can be expected to be attracted to Canada.

Canada imports large quantities of raw material from the United States, especially coal and iron. These raw materials are essential to her industrial development. It would seem that under these conditions there should not be any serious objection to the export of excess water power, especially if arrangements can be made to withdraw this power from export when required for home consumption, and the use of the water power will help save the fuel resources from which her supply comes. This would also make her power system part of one that in future years would undoubtedly be extremely advantageous, if present-day benefits of interconnected systems are a criterion.

Why Discard the Machine?

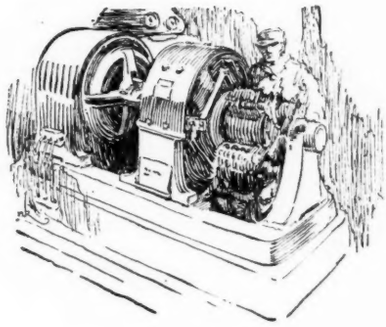
PROBABLY eighty per cent of the weight and as great a proportion of the cost of an engine is made up of parts subject to little or no wear. It is somewhat surprising, then, that so many steam engines are scrapped or sold second-hand when the greater part of the machine is still as good as new. Of course this rejection is due not to a complete wearing out of the engine, but to the fact that the engine's cylinder and valves have become so worn as to call for another reboring, which the cylinder walls will not stand, or to a lack of efficiency which is possessed by a more modern design.

When a cylinder will not withstand reboring, the purchase of a new cylinder and valves will cost far less than will an entire new machine. A new lease of life is given at the comparatively low cost of cylinder replacement, and the engine is even better than a new one.

If the low efficiency of an engine seems to call for the installation of a new unit, before this expense is undertaken it is well to investigate the possibilities of adapting the new cylinder design to the existing frame; for after all, any gain in efficiency lies in the cylinder. A new generating unit, as a rule, calls for a new foundation, a new dynamo, rearranged pipe, as well as the engine itself. A modern-designed cylinder and valve gear will cost probably but twenty per cent of this amount.

Modernization of existing engines is being carried on in many plants, but not to the extent it should.

Practical Ideas from Practical Men



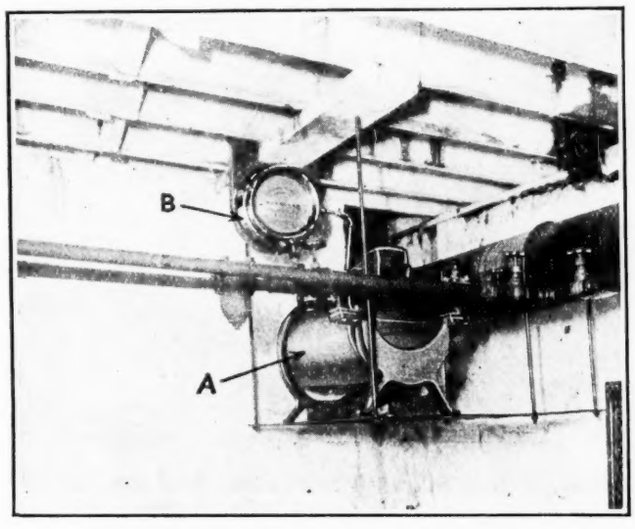
WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. Three prominent operating engineers have been invited to act as judges. The winners for January will be announced this month.

Recording Steam Trap

When steam traps are installed in a convenient place in the boiler or engine room, they naturally receive the same care as the other machinery, but many times they are placed out of sight and receive very little attention.

The illustration shows a large tilting steam trap that takes care of all the condensation of steam lines of a large power house. The trap is placed on a steel plate which is suspended by four steel rods from the ceiling of the basement. The trap discharges to an open heater against a 15-ft. head. The balance lever of the trap is connected, through a link, to the lever of a "revolution counter," so that every discharge of the trap is recorded by the counter. In this way the counter serves as a check on the operation of the trap.

The reading is taken from the recorder every Monday morning and is at once compared with the reading for the previous week. If it does not check up very closely, the trap is examined at once and made to work properly. It has been my experience that when traps discharge into an open heater or a hotwell where the discharge cannot be readily seen, a great loss of steam can take place unless some means are provided to show when the trap fails to operate properly.

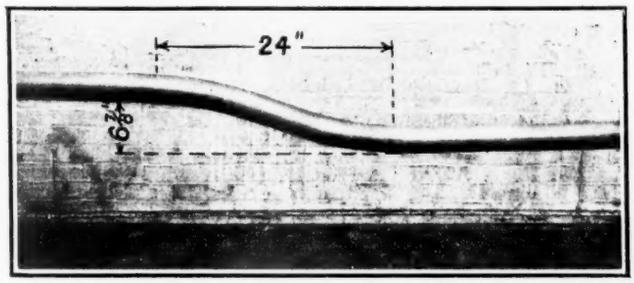


A comparison of the weekly counter readings serves as a check on the operation of the trap.

Norway, Mich. THOMAS PASCOE.

Why Did the Tube Bend?

The illustration shows the bend in a tube that we removed recently from one of our horizontal water-tube boilers. As I believe this to be somewhat unusual, I should like to hear from some readers of *Power* as to the probable cause for this tube bending as shown by the photograph.



Bend in tube removed from horizontal water-tube boiler

C. W. SNYDER.

Norristown, Pa.

Ice-Plant Kinks

The white collar generally found on the top end of each block of raw-water ice can be practically eliminated by not sucking cores until they are much smaller than is the usual practice and by keeping the water level an inch or two below the top of the block when refilling the cores. In high-pressure agitation it is good practice to reduce the pressure of the air to each row of cans as soon as cores have been sucked. This will stop the water in the cores from being blown out. Any water that is blown out of the cores will freeze without agitation and of course will be white ice.

Last summer, during the warm weather, we found it possible to keep our output of ice up to normal by refilling the cores only about one-half full and pulling the ice as soon as this amount of water was frozen. The ice was then stood on end in the storage room and the hole filled with water. The water would be frozen within twenty-four hours and we not only got a block of clear full-weight ice, but cut down the freezing time in the tank two or three hours, which enabled us to keep production up to normal.

It should be possible in small plants using the high-pressure air system to freeze cores quite small and pull

the ice without sucking the cores. If the ice is placed on end in the storeroom and the cores filled with clean fresh water, they will soon freeze solid and the extra capacity of the tank will more than pay for the small amount of extra labor involved. B. C. WEAVER.

Napa, Calif.

Automatic Fuel-Oil Pumping System for Diesel Plants

In the majority of oil-engine plants the fuel supply is stored in an outside underground tank and is pumped by hand into small vertical tanks from which the oil

Motor-driven fuel-oil pump

flows to the engine fuel pumps. It is almost imperative that the hand oil pump be located inside the engine room, while the tank, for fire prevention, should be at least twenty-five feet away. In cold weather the oil gets sluggish, and even with a fairly large diameter suction pipe the pump may not be able to draw the oil up from the tank and through the pipe. It is by no means unheard of for an engineer to be compelled to carry oil in pails owing to failure of the pump.

To avoid this difficulty in a Louisiana plant containing three Diesel engines, the chief engineer installed an automatically controlled motor-driven oil pump. The pump is located close to the large storage tank, while the motor and reduction gear are placed within the building, the drive being through ⅞-in. shafting.

The engine service tank is fitted with an overflow line leading back to the storage tank so that it will not flood. The pump discharge leads into the bottom of the service tank, and the diaphragm of a pressure-controlled electric switch is connected to this discharge line. The regulator is so set that just before the oil level in the service tank reaches the overflow opening, the pressure in the pump-discharge line is sufficient to open the electric switch, thereby stopping the motor. As soon as the level drops a few inches, the switch closes.

Beyond making the oil pumping more positive, there is an additional advantage. Service tanks are usually provided with a level indicator, and the daily or hourly fuel consumption of the engine is calculated from these level indications. It is common to find serious errors in these calculations. With the pumping arrangement outlined, an oil meter is placed in the discharge line and hourly and daily records are obtained by direct reading.

St. Louis, Mo. GEORGE GROW.

An Unusual Operating Detail

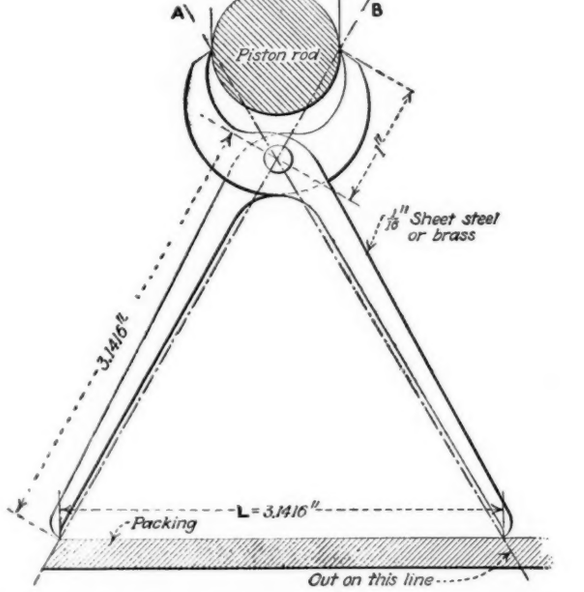
We recently encountered a rather unusual condition in renewing a bent tube in a class S-20 Stirling boiler. Previous to this no tubes had been put in. It would have given the designer of the boiler installation something to think about if he had been compelled to put in the tube.

The leaky tube, which was in the first pass and next to the baffle, was first cut out with a torch. Then the new tube was passed up through the inspection door in the front of the boiler, but it hit a parabolic coal bunker and could not be placed in the boiler no matter how it was turned or twisted. Next some brick and tile were removed from between the front and middle steam drums. The tube was started through this hole, but would not go in because it struck the boiler-room roof. With all the versatile adroitness that comes to one in a tight squeeze, a hole was finally cut through the concrete roof, and the boiler tube at last dropped into place. This little incident might be described as an operating detail or "something else." H. M. TOOMBS.

Chicago, Ill.

Tool for Determining Length to Cut Piston-Rod Packing

When cutting piston-rod packing from stock supply, a guess is usually made as to how long to cut the piece for the ring, and usually more is cut off than is



Long ends of calipers register length of ring, when short ends are placed over rod

needed. By using calipers, as illustrated, the exact length is readily determined before the cut is made.

The circumference being equal to 3.1416 times the diameter gives the basis for making this tool, the long ends of the calipers as shown, being 3.1416, or practically 3¼, times the length of the short ends. When applied to the piston rod of 1 in. diameter, for instance, the spread of the long arms, or the distance *L*, will be 3.1416 in. This, of course, will be the length of the inside circumference of the ring or the piece to be cut

off. The packing should be cut at an angle, and if this angle is kept with the line of the inside edges of the caliper arms as illustrated, then the outside length of the packing will be approximately correct when the ring is fitted to the rod.

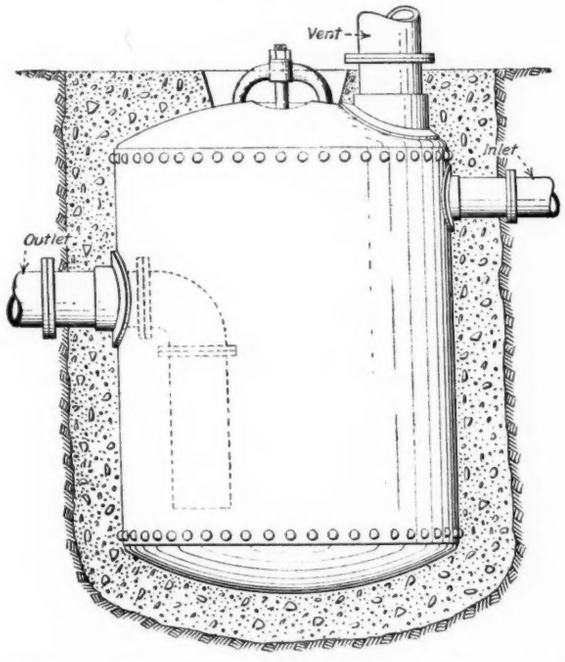
The tool may be made from $\frac{1}{16}$-in. thick sheet steel or brass, the exact positions for the four points relative to the joint pin being found by measuring the distances shown on the two lines *A* and *B*.

North Bend, Neb. G. G. McVICKER.

Quick Repair to Underground Blowoff Tank

The illustration shows the method we employed of repairing a blowoff tank. The tank was of steel construction and had been in service about three years when it became necessary to make some repairs. First, the top head was welded in several places where the acid water from a near-by "ash dump" had eaten the material away. This repair lasted about six months, then the shell broke out in other places necessitating extensive welding.

After a thorough examination it was decided to incase the tank in concrete. Accordingly, a space about 6 in. wide was dug all around the tank and at one side a trench was dug for convenience in removing the dirt from under the tank. The excavating completed, a few



Welding and patching of shell eliminated by incasing tank in concrete

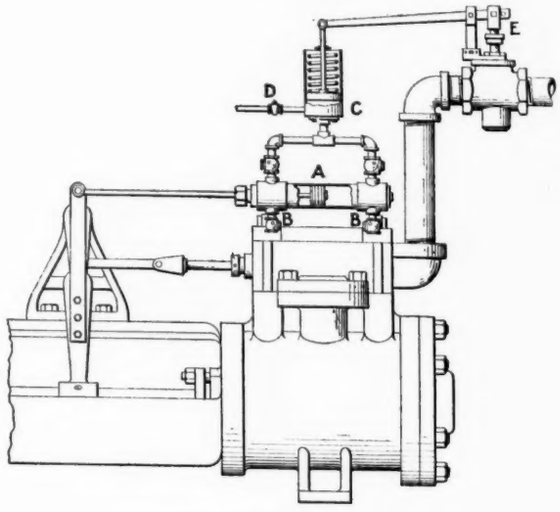
boards were placed across the clean-out trench and were ready to pour the concrete. The space was filled with concrete (mixed wet) to a point level with the bottom of the vent pipe flange, leaving just sufficient room to turn the nuts on the flange bolt. The concrete was reinforced with pieces of iron rod as the pouring proceeded. The repair proved a success as it has given no trouble for five years and bids fair to last five years more. S. W. STEARNS.

Beloit, Wis.

Engineer Makes a Pump Governor

In a factory using much steam for drying purposes, the condensation returns were handled by a duplex steam-driven pump. The flow of condensate, as is usual in heating systems, was very irregular. As a consequence the pump often speeded up to a dangerous extent, making repacking an almost continuous event.

The engineer recommended the purchase of a standard pump governor, but the requisition was turned



Governor made of pipe fittings

down by the purchasing agent. Not enjoying the every-Sunday job of repacking, the engineer turned his attention to the stockroom and by assembling several pipe fittings, made the governor shown in the illustration.

The body *A* consists of a short length of pipe screwed into two crosses. Suction valves *B*, as well as the discharge valves, are plain $\frac{1}{4}$-in. brass check valves. The dashpot *C* is made of a piece of pipe and a reducing bushing, while *D* is a $\frac{1}{4}$-in. cock. An old feed-water heater valve *E* was placed in the steam line as shown.

The action is as follows: The plunger of the compressor *A* is fastened to one of the pump valve-rockshaft levers. Air enters through *B* and is discharged into the dashpot *C*. The valve *D* is opened enough to permit this air to escape without lifting the dashpot piston. If the pump speeds up, the compressor pumps more air, which cannot escape through *D* fast enough to prevent the piston in *C* from being raised. Upward movement of this plunger reduces the opening in the control valve *E;* this checks the steam flow to the pump and brings the speed back to normal. G. SCOTT.

St. Louis, Mo.

Scale in Pipe Affects Reading of Flow Meter

Some time ago I noticed that the water rate of our station, as determined by a flow meter connected in the boiler-feed line, was gradually becoming higher each succeeding month, without any apparent cause. A water-column test on the meter showed it to be accurate to within one per cent. The piping to the meter was examined and found to be clear.

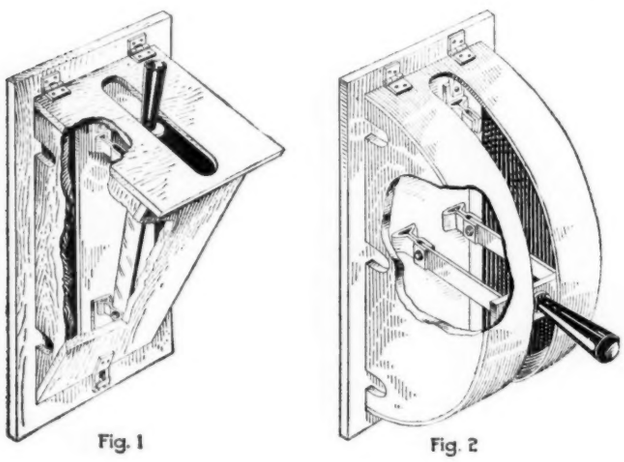
The trouble was finally found in the pipe in which the pitot tube is installed. This pipe had become coated

with scale of sufficient thickness to reduce materially the area of pipe. The scale was not of uniform thickness; in fact, it was of a rather warty or rough character. This evidently caused the water to flow at a more rapid rate and to swirl through the pipe, causing inaccurate registration of the flow meter. After clearing all the scale out of the pipe the meter is apparently registering accurately. It is hoped that this brief description of our flow-meter trouble, with its cause and remedy will be of some benefit to those who have water-flow meters in their charge.

Rawlins, Wyo. CURTIS L. OVERLY.

Easily Made Safety-Switch Boxes

In industrial plants every electric switch should have a suitable guard or protection around it, making it impossible for any person to come in contact with the metal parts of the switch. After a series of experiments with various kinds of guards and boxes, I made up and have used quite a number of safety switch boxes, as shown in Figs. 1, 2 and 3. For a single- or double-pole single-throw knife switch, that shown in Fig. 1 was used. It consists of five pieces of fireproofed wood—the back, two sides, the front and the top piece. The switch is mounted on the back-board, while the top piece is so fitted as to allow only sufficient room for the handle to operate in. The top piece, two sides and front are assembled together to form a unit. Slots are cut in one or both sides to allow for the entrance of the wires, the size of these slots depending upon the size of insulator used. The top end of the box is hinged to the base and the bottom is fastened to the base by a T-head catch, a half-turn of which allows the box to be swung up out of the way, thereby making the switch accessible for inspection and repairs. In



Figs. 1 and 2—Switch boxes made from fireproofed wood

this style of switch box only the wooden handle is visible, and this is the only part of the switch that can be taken hold of with the box closed. In Fig. 2 is shown a safety switch box for a double-throw knife switch. The back and sides are made of plain fireproofed wood, while the front is of three-ply lightweight built-up board. This material is flexible and can be shaped easily. A slot is cut in the front just large enough to allow the switch handle to project through. The assembling of the switch box is practically the same as for the one shown in Fig. 1. The boxes are given at least two coats of non-conductor paint or varnish. This results in a neat appearance and prevents the wood from absorbing any moisture.

In Fig. 3 is shown a metal safety box that was used for inclosing switches for controlling small motors and secondary circuits. This box is made of sheet metal and lined inside with sheet asbestos. The back, sides

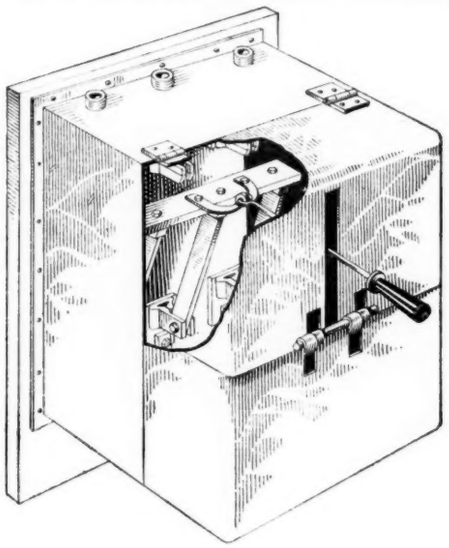


Fig. 3—Metal switch box lined with asbestos

and one-half of each end are assembled as a unit with bolts or rivets. The front cover is so made that it is in two pieces, each being bent to form one-half of each end and one-half of the front. The upper half has a small slot cut in the front to slip over the operating rod. The two front parts have interlocking turned up edges and are held together by a small rod, making the box readily accessible for inspection. Porcelain sign bushings with wire locks are used for the entrance of the wires. The operating rod is hinged to the insulating crossbar of the switch blades, and the end of the rod on the outside of the box has a wood or fiber handle.

In damp places I have found it a good idea to give all slate switch bases a coat or two of shellac. This prevents the slate from absorbing moisture and causing current leakage across the switch terminals. The use of untreated asbestos for lining switch boxes is satisfactory in dry places; in damp places the asbestos should be given at least two and preferably three coats of shellac to prevent its absorbing moisture. In very damp places it is well to have a lamp burning at all times inside the switch box or cabinet. This gives a visual signal that the current is on and keeps the switch box dry and safe.

A metal switch box should always be well grounded. The size of ground wire has been determined by the National Board of Fire Underwriters, and the recommendations are that a wire smaller than No. 10 should not be used where the circuit has a capacity of 100 amperes or less; where circuit capacity is between 100 and 200 amperes, not less than No. 6; for 200 to 500 amperes, not less than No. 4; and above 500 amperes, not less than No. 2 wire.

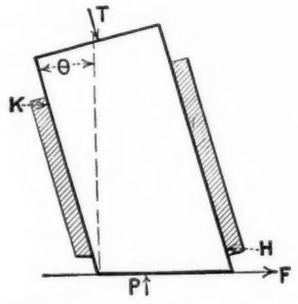
San Bernardino, Calif. FRANK HUSKINSON.

Comments from Readers

Brush Angle and Direction of Commutator Rotation

I desire to submit the following comment on an article by W. C. Kalb entitled "Brush Angle and Direction of Commutator Relation," published in the issue of Dec. 16, 1924, page 973.

In this article it is assumed by Mr. Kalb that the force H, Fig. 2, reproduced herewith, exerted by the brush-holder on the brush varies only with the spring tension on T, angle of inclination θ and friction F, therefore he was able to plot curves between the ratio $\frac{H}{T}$ and degrees inclination θ for a brush having a certain coefficient of friction. I desire to point out the fact that there is another force not taken into consideration which is appreciable and therefore should not be neglected. This force is designated as K in the figure. The actual value of H is: $H = K + F \cos \theta + P \sin \theta$.



Brush in trailing position

Neither K nor H can be calculated unless the dimensions of the brush-holder and the distance of the brush-holder from the commutator are known.

The value of K is relatively small only when the toe of the brush-holder is close to the commutator and is never zero except when the brush is in a certain leading angle. It is understood from Mr. Kalb's article that the force K was neglected, which is equivalent to assuming K equals zero. It, therefore, appears that the values of H in actual practice may be expected to be greater than shown by the curves in Mr. Kalb's article.

W. E. STINE, Assistant Material Engineer,
Brooklyn, N. Y. Building No. 22, Navy Yard.

Referring to the comment by W. E. Stine on the article "Brush Angle and Direction of Commutator Relation" which appeared in the Dec. 16 issue of *Power*, the writer agrees with Mr. Stine that there is a force which he terms K that must be considered in accurate quantitative calculations of the relations described in that article. Furthermore, the value of this force K is related to the brush-holder dimensions and the distance of the holder from the commutator.

It was the intention of the writer, however, in the article in question to treat of the subject from a qualitative rather than a quantitative viewpoint. This led to the omission of the force K from consideration. It also led to the assumption that the brush tension is applied at the center of the brush top in a direction parallel to the sides of the brush and, therefore, without a component of side thrust against the holder box. This is an ideal condition seldom realized in practice.

The inclusion of these elements, however, greatly complicates the equations involved without modifying to a pronounced degree the conclusions reached. If it is desired to determine the value of the force K, it may be done by means of an equation of moments about the point marked H in Mr. Stine's figure. This equation will disclose that the force K has a negative value at normal trailing angles of operation with brushes of average coefficient of friction unless the brushes are very thin or the distance of the holder from the commutator greater than is generally recognized as good practice. A negative value of K means that the pressure at the top of the brush is against the trailing rather than the leading side of the holder so that the equations used in the original article are not changed by the consideration of this force.

W. C. KALB, General Manager,
Bradford, Pa. Corliss Carbon Company.

Suggestions for the Steam-Table Makers

As a reader of *Power* on "the other side," I have followed with great interest the various articles touching on the work of the Bureau of Standards in connection with the new steam tables. Considerable time must necessarily elapse before these tables are published, and when they appear it may be confidently expected they will be a complete and standard reference work for many years to come.

Concerning their scope and method of presentation, may I be permitted to put forward a few suggestions in order to invite criticism and discussion from practical engineers and students, which during this interval may bring out useful ideas worth embodying in these tables from their point of view?

In England we have separate publications for steam tables, heat-drop tables (both absolute and gage pressures) and correction tables. Why not issue a "one story book" to include these in one publication, together with a larger heat-entropy chart on which the volume lines appear, also a list of conventional signs and definitions standardized on common-sense lines to avoid the chronic looseness of terminology which bewilders the student and practical man?

I venture to offer some further suggestions as follows: The tables should range from 0.1 lb. absolute to 3,200 lb., include latent heat to the vanishing point, and give specific heat in all tables. Small figures giving differences for interpolation should be inserted between all vertical values, also between horizontal values where

useful (as in heat-drop tables to facilitate the getting out of correction curves).

Do not give values for graduated steps of superheat, but rather of total thermometer temperature *t*. Give a table for heat and entropy for "supersaturation" lines and undercooling curves to at least 50 deg. F. below the Wilson line, while printing the values for the latter in heavier type. Give a table of heat drops to 25-in. and 29.5-in. vacuum in small steps, and also to atmospheric pressure to facilitate calculations of output and steam consumption when running non-condensing.

The tables should be so detailed that a really complete heat-entropy chart could be plotted from them entirely without recourse to any calculation work other than the simplest interpolation.

I could suggest further points, but fear they would encroach too much on your valuable space. However, I would like to conclude with the following:

"Dry" steam, that is, steam in which the water has just fully evaporated, is variously termed "saturated" steam or "dry saturated" steam. Either it is dry or it is not, so why not definitely call it dry steam? The "saturation" line or "dry-saturation" line should similarly be called the "dry-steam" line. All steam of temperature above that of dry steam is defined as "superheated" steam, while steam (under normal conditions) containing various degrees of moisture below the dry steam line, is "wet" steam and the term "saturated" steam could be eliminated. We then have clearly defined the three chief states of steam.

"Supersaturated" steam would be best replaced by the term "under-cooled" steam, meaning dry or superheated steam possessing a temperature lower than it should while remaining uncondensed. The term "supersaturated" is a misnomer as applied, indicating that the steam is extremely wet or more highly saturated, whereas it is quite the opposite and does not revert to the condensed state until the Wilson limit is reached.

Birmingham, England. M. H. SABINE.

Oil Engines for Ice Plants

Referring to L. G. Black's inquiry, page 271 of *Power*, Feb. 17, regarding the installation of an oil engine in his ice plant, the problem could have been solved more easily had he given more specific information as to the sizes of the compressors and whether belt driven by motors or direct connected to the steam engines.

It is presumed that this plant is manufacturing distilled-water ice. If that be the case, a shortage will occur in water if the capacity is increased without increasing the amount of exhaust steam available for distilled water. On the other hand, if this plant has a raw-water system, the water phase of the situation need not be considered.

It has always been my policy to standardize in any phase of engineering where it is possible. If the plant is steam, if practical I would continue with steam.

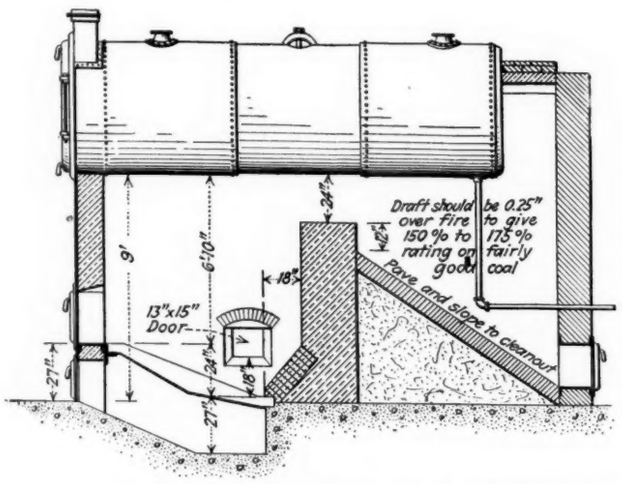
Steam engineers are not oil-engine operators, and it matters not how simple the machine may be, one must pass through an experimental state, which is sometimes costly. I have observed under operations practically all types of refrigerating equipment, and while motor drive is a very tempting thing to both the purchasing agent and the inexperienced engineer, a comparison of repair bills, including loss of production from delays that are more likely to happen with the motor and belt-driven equipment, shows that direct-connected steam-driven compressors are best in a distilled-water plant. My recommendation would be to increase the steam capacity and forget the oil engine. I advise the engineer to write to about three refrigerating manufacturers, requesting them to send their sales engineers to inspect present conditions and submit prices upon any new equipment they should deem necessary.

Galveston, Tex. H. W. ROSE.

What Is Wrong With the Boiler Settings?

With reference to the inquiry of J. Billings in the Jan. 20 issue, "What is Wrong with the Boiler Settings," it would appear that the trouble is due to excess air coupled with improper furnace design. The illustration herewith shows a layout suitable to the conditions he gives.

A company with which I am familiar had two boilers of the same type and size set 10 ft. to the shell from the floor. It was impossible to secure more than 56 per



Cross-section of furnace showing typical arrangement for hand stoker installation

cent combined efficiency until stokers of the hand-operated type were installed and the furnace reconstructed. After these changes were made, the acceptance tests showed over 70 per cent combined efficiency.

Although some of the particulars of the setting, as given by Mr. Billings, are somewhat indefinite, I should like to make the following suggestions:

1. Place a side-wall inspection door in each furnace, at the point shown on the sketch.
2. Remove the arch over the bridge wall.
3. Carry the bridge wall up to 24 in. from the shell.
4. Fill the rear combustion chamber as shown. This is really important.
5. If on natural draft, carry about 0.25 in. draft over the fire, which should be sufficient, on 42 sq.ft. of grate area, to burn 25 lb. fair grade soft coal per square foot per hour. At 65 per cent combined efficiency on 14,000-B.t.u. coal this should give between 50 and 75 per cent over rating.
6. If on forced draft, keep the back end of the stoker covered and avoid holes. Install two draft gages—one for ashpit pressure and one for draft over the fire. Try to carry less than 0.10 in. over the fire, with forced draft.

D. T. DOBYNS.

New York City.

Questions and Answers

Conducted by

Franklin Van Winkle

Wear of Engine Cylinders

In what part of the cylinder of an engine is the greatest wear from the piston? *W. D. S.*

In long-stroke slow-speed engines the greatest wear comes in the bottom of the cylinder and usually at the middle of the stroke of the piston. In high-speed short-stroke engines that run over, especially when provided with heavy connecting rods, the greatest wear usually occurs on the bottom of the cylinder nearer the head end.

Underloading Slide Valve Engine

A slide valve engine of 100 hp. capacity running fully loaded is to be relieved of about two-thirds of the present load with the same boiler pressure and engine speed. What change should be made in the valve setting? *B.B.T.*

Obtain earlier cutoff by advancing the eccentric, but not so much that release will occur earlier than about $\frac{7}{8}$ of the stroke, or that compression will be high enough to raise the valve off its seat.

Relative Holding Power of Flared and Beaded Tube Ends

Has a beaded tube more staying power than one that is simply flared at the ends? *R. N.*

Tests have shown that beaded tube ends have not as much holding power as tube ends that are simply flared. Beading is performed after expanding and the flaring have been completed, and the operation of beading has a tendency to disturb the hold obtained in expanding and flaring and besides is likely to impair the texture of the tube material.

Lap of Corliss Exhaust Valves

What is the objection to giving Corliss-engine exhaust valves too much lap? *J. G. B.*

By lapping the exhaust valves they are opened after the wristplate has come up to the central position and closed before it is swung to one side and returned to the central position. Hence with exhaust lap there will be a later release and earlier exhaust closure, giving more compression. This must not be carried too far, since compression reduces the capacity of the engine and should not be more than necessary to obtain smooth running. In addition, it is not desirable to have release occur so late that more is lost in back pressure in the beginning of the exhaust stroke than is gained by holding the steam nearer to the end of the forward stroke. In the average Corliss engines the best release conditions are obtained when the exhaust valves are set without lap and the eccentric is advanced sufficiently to obtain enough compression for smooth running of the engine.

Discharge Check Valve on Ammonia Compressor

Why is it that ammonia check valves are not installed more on the discharge side of ice machines? Is not an ammonia check valve a good thing to relieve head pressure and avoid leaking back? *E.C.R*

Every compressor should be fitted with a discharge check valve, and most modern units are so equipped. It should be placed above the discharge globe or gate valve to permit repacking of the latter valve without putting out the discharge lines. A recent arrangement is to provide a hinged discharge stop valve of the non-return type. This will always permit the compressor to discharge into the line as long as the pressure is above that in the condenser.

Allowance for Expansion of Steam Pipe

What allowance should be made for expansion in length of a 125-ft. run of 3-in. covered steam pipe that is to convey steam at 200 lb. gage pressure, superheated 150 deg. F.? *S. D. E.*

The temperature of dry saturated steam at 200 lb. gage pressure is 388 deg. F., and when superheated 150 deg. F. the temperature would be $388 + 150 = 538$ deg. F. If the pipe were erected when the temperature was 60 deg. F., the whole change of temperature would be $538 - 60 = 478$ deg. F. The mean coefficient of expansion of iron or steel pipe through this range of temperature would be about 0.0000065 of the length per degree change of temperature, and the total expansion of 125 ft. would be $478 \times 0.0000065 \times 125 = 0.388$ ft., or about $4\frac{5}{8}$ in. If the pipe is well insulated, the amount of expansion would be substantially the same.

Static Electricity from the Blowing of a Safety Valve

Why does an 8-ton tandem asphalt steam roller become so charged with electricity when steam is blowing off, that it is difficult to handle the throttle? *O. E.*

When steam is discharged at high velocity through a small aperture, there is development of static electricity due to the friction of globules of water against the sides of the jet. The escaping steam is charged with positive electricity and the boiler becomes negatively charged. The effect will be more pronounced if the boiler and connections are supported on a non-conducting material like asphalt and a person whose body was previously insulated from the boiler would experience the shock of a feeble electric discharge from grasping the throttle or touching the boiler. A remedy would be to provide a number of metallic points in the path of the escaping steam an inch or two from the safety valve and have these connected back to the boiler.

Adjusting Crosshead Shoes

Where should the crank of an engine stand when adjusting the height of the crosshead shoes? *M. G.*

For adjusting the height of shoes, place the crank on dead center with the piston in the head end of the cylinder, so the crosshead will be at the head end of its stroke. The shoes then should be adjusted to bring the piston rod central with the rod packing. If the slides are in line with the cylinder, turning the engine on the crank-end dead center should give the same clearance between the rod and packing. If the clearance is not the same, adjustment of the shoes should favor freedom of the rod when the crank is on the head end center, for the crosshead then is nearer the cylinder than in any other point of its travel and any lack of alignment with the packing in that position would cause greater pressure and wear of the rod than the same error of alignment at any other point of the stroke.

Advantage of Butt and Double-Strap Joint

For the longitudinal seam of a cylindrical boiler shell, why is a butt and double-strap joint stronger than a lap joint? *C. R. D.*

One type of joint may be designed initially as strong as the other, but from continued use the plates of lap joints, by bending along the joints, are likely to become cracked and so much reduced in strength as to rupture. Stress on the joint from internal pressure of the boiler has a tendency to draw the margins of the plates into the same circular form as that assumed by the rest of the shell, bringing a tension as well as a shearing stress on the rivets, and repeated bending action that is induced by changes of pressure frequently results in failure of the plate along the joint near the edge of the overlapping plate.

In a butt and double-strap joint the plates may be fabricated to the circular form of the shell and the margins are held to that position by the straps; most of the rivets are in double shear without tension, and in a butt and double-strap joint of standard design, any bending action that would be productive of rupture is prevented by the form and stiffness of the straps.

Paradoxical Operation of Check Valve

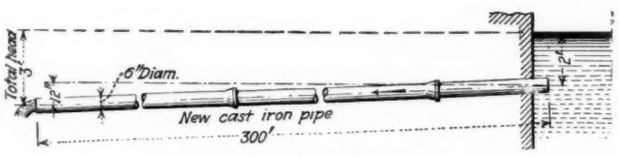
In a boiler plant a return trap is provided with a swing check valve at the inlet and at the outlet. What causes the outlet check to open? The combined area of the valve opening and seat for receiving pressure of the boiler is greater than the valve opening alone against which the trap discharges with the same boiler pressure, and the small head of water on the trap side is insufficient to overcome the boiler pressure acting on the area of the valve seat. *C. L. S.*

The area of valve seat on which the boiler-side pressure acts in excess of the projected area of the valve that receives pressure from the trap is only the area of contact between the valve and seat. For sealing the valve, this area of actual contact usually is only a small fractional part of the whole machined area of the valve seat, and as the pressure per square inch becomes more nearly the same on opposite sides of the valve, this seal area, from elasticity of the material, becomes reduced from warping of the valve or seat, or both. Practically all types of check valves obtain greater area of contact for higher than for lower pressure, and many types of check valves that are tight for considerable difference of pressure leak for less difference of pressure. In any event the discharge check on a return trap would not be opened when the steam pressure on top of the water of the trap is equal to the boiler pressure, unless the head of water in the trap is sufficient to raise the weight of the valve and overcome the pressure acting on the area of actual contact of the valve with its seat. In considering the pressure acting to keep the valve closed, it must not be overlooked that this pressure is reduced below the boiler pressure by the head of any water that may be in the connection between the trap and the boiler above the water level in the boiler.

Delivery of Water by Six-Inch Pipe Line

What number of gallons of water per minute would be discharged into the atmosphere through a smooth 6-in. cast-iron pipe, flowing full, 300 ft. long, gradient 4 in. per 100 ft. and water entering the upper end under a constant head of 2 ft., as indicated in the sketch? *T. N. W.*

The exact quantity of water that would be discharged cannot be determined by computation unless the loss of head from pipe friction of the particular pipe line



Pipe line under total head of 3 ft.

is known or assumed. However, results close enough for most practical purposes may be obtained by interpolation of tabulated values given in works on hydraulics.

By reference to Weston's tables founded on a modification of Darcy's formula giving the loss of head due to friction of water in pipes having interior sides similar to new cast-iron pipes, it may be seen that for a discharge of 300 gal. per min., requiring a mean velocity of 3.4 ft. per sec., the head in feet required to produce this velocity = 0.18 ft.; loss of head per 1,000 ft. of pipe = 8.36 ft. or for 300 ft. = 8.36 × 0.3 = 2.508, and loss of head due to orifice of influx = 0.09 ft., making the total head required, 0.18 + 0.9 + 2.508 = 2.778, or less than the total head available. For discharge of 325 gal. per min., requiring a mean velocity of 3.69 ft. per sec., the head in feet required to produce this velocity = 0.21 ft.; loss of head per 1,000 ft. of pipe = 9.82 ft., or for 300 ft. 9.82 × 0.3 = 2.946 ft., and loss of head due to orifice of influx = 0.11, making the total head required 0.21 + 0.11 + 2.946 = 3.266 ft.

For an increase of 325 — 300 = 25 gal. per min., the required increase of head would be 3.266 — 2.778 = 0.488 ft., or within these limits an average increase in discharge of 25 ÷ 0.488 = 51.23 gal. per foot of head per min. As the total available head is 3 ft., or 3 — 2.778 = 0.222 ft. more than required for 300 gal. per min., by interpolation, the discharge with the total head available would be 300 + (0.222 × 51.23) = 311.4 gal. per min.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

New and Improved Equipment

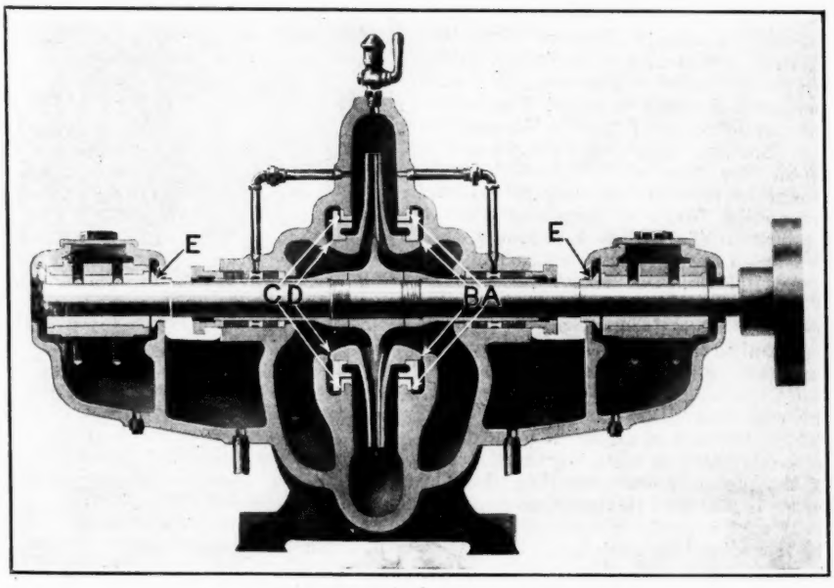
Earle Centrifugal Pumps

A line of double-suction centrifugal pumps in which the end thrust is taken care of automatically by neutralizing the pressure on the sides of the impeller has recently been developed by the Earle Gear & Machine Co., Philadelphia, Pa.

The general design of the pump is clearly shown in the illustration. The usual split casing is employed and split babbitted bearing shells with two oil rings are provided. Bronze sleeves protect the steel shaft from the liquid handled, and deep stuffing boxes fitted with a brass bottom ring and brass water-seal rings are provided.

A feature of the pump is the method of neutralizing the pressure on the sides of the impeller. Referring to the illustration; if the thrust is toward the right, the radial seat at *B* will tend to close, while the radial seat at *A* is opened, building up a pressure on the total area of the right side of the impeller. While this is taking place, the radial seat at *C* has closed, and the radial seat at *D* has opened, placing a suction or reduced pressure on the area of the left side of the impeller. Consequently, the pump rotor will tend to move slightly to the left until it reaches a point at which the total pressure will be the same on both sides of the impeller and hydraulic balance is obtained. The opposite cycle of events takes place if the original thrust is toward the left.

Owing to this hydraulic balance no thrust bearing or collars are used. However, as wear will ultimately take place on the sealing rings inside the pump casing, small fixed collars *E* are placed on the shaft close to the inner end of each bearing as shown. These collars are set at a distance from the face of the bearing bushing, which will not permit them to become operative until the limit of allowable wear has taken place on the sealing ring. The engagement of the collars and bearings is an indication of the need of replacement of wearing parts within the pump.



Cross-sectional view of centrifugal pump

Traveling Grate for Return-Tubular Boilers

To make it possible for small boilers to use economically a traveling grate, the United Stokers Co., of Laporte, Ind., has adapted its standard "W" type traveling grate for this service. While the general design is much the same, the weight has been reduced, so that the new stoker is obtainable at an initial cost comparable with that of the hand stoker.

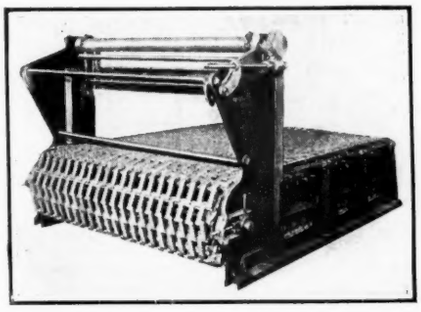


Fig. 1—"S" type traveling grate for small boilers

This new development, known as the "S" type traveling grate, is made as small as 21 sq.ft., of active grate area, which is suitable for a boiler having 800 sq.ft., of heating surface, such as is contained in a 54-in. by 16-ft. horizontal return-tubular boiler. It is made in any appropriate size above the lower limit given, depending upon the load, draft and coal conditions.

In general the design and construction follow closely the larger stoker made by this company. Owing to the fact, however, that large numbers of small boilers are low set, it was considered essential that the stoker be designed to take care of such units and provide an acceptable furnace by limiting the height from the floor line to the top of the grate surface to 24 in. The general details of the new stoker are shown in the front view, Fig. 1. It will be seen that the usual continuous side pieces of the frame have been replaced by vertical columns stiffened by cross-members and the longitudinal tracks on which the rollers travel.

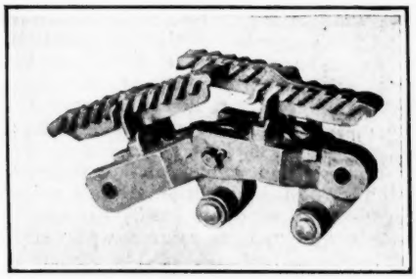


Fig. 2—Sections of drive chain

Reference to Figs. 2 and 3 will show that the grate surface is constructed in the same way as for the large traveling grate. The fuel-supporting members are carried on grate bars which in turn are fastened to drive chains,

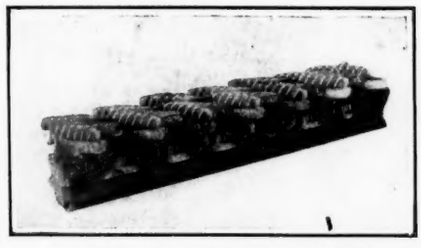


Fig. 3—Grate carrier bar

the drive-chain links embodying the standard roller construction of the larger stoker. The grates are made from the same patterns as those used on the large machine, and the method of keying each grate in place is identical. This makes it possible to replace any grate without stopping the stoker or disturbing any other grate, and as

one pattern is used for the entire grate surface, the various elements are interchangeable.

To guard against infiltration of air at the furnace side walls, a double set of ledge plates are used and kept independent of the stoker. The upper ledge plate supports the overhang of the furnace wall. The lower ledge plate is adjustable and can be brought up to the grate surface as occasion demands.

The feed gate and operating mechanism are the same as those employed in the larger stoker. The usual worm and drive wheel are employed, and tension take-up for the stoker chains is from the front. The worm, however, is placed below the wheel and runs in an oil bath. Either a motor or an engine can be used to drive the stoker.

Owing to the small size of the stoker and the comparatively small quantities of coal required by a boiler of low capacity, ashpits with capacities of from eight to ten hours' storage can be installed without exceeding a depth of pit of 3½ ft.

For ignition, a special flat arch has been designed to eliminate all structural-steel supports and thus give maximum furnace volume under low-set boilers.

Mallen Flow Meter

A type of flow meter developed primarily to meet the need for a simple and inexpensive instrument to measure the flow of liquid in pipe lines has been brought out by the Statewide Engineering Co., Indianapolis, Ind. A general view of the device is given in Fig. 1 and a diagram showing the principle of the meter in Fig. 2.

Referring to Fig. 2, a well containing mercury, is connected to the header before and after an orifice in such a way that practically all the movement of the mercury is in one leg only, the level of the mercury in this leg indicating the flow in the pipe line. The meter is constructed almost entirely of standard pipe fittings, and with the exception of the mercury and a float, which rides on top of the mercury, it has no moving parts. The orifice plate is made of ⅛-in. sheet brass and is designed to fit betwen the two flanges of a flanged joint.

A scale graduated in cubic feet per minute, per cent builders' rating or pounds per hour, depending upon the service for which the meter is to be used, is placed directly behind the mercury column. The zero point is readliy checked by opening the pressure equalizing valve, and the scale is adjusted by means of a screw at the top of the instrument.

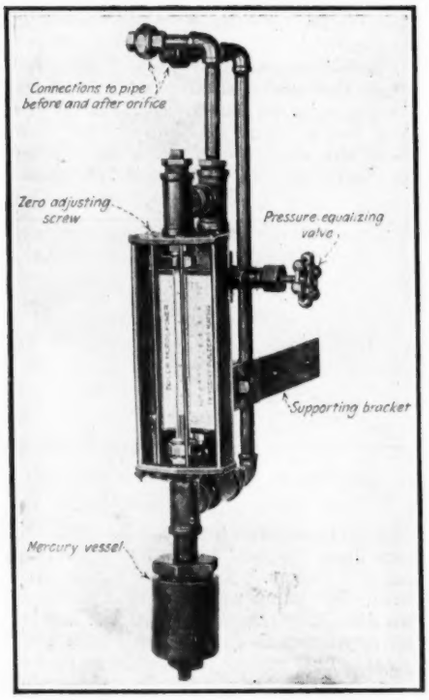


Fig. 1—General view of instrument

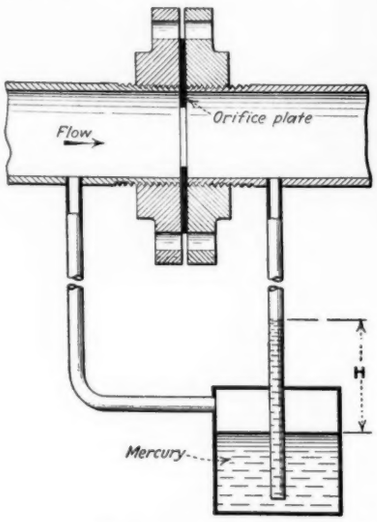


Fig. 2—Diagram showing principle of meter

Republic Coal Meter for Traveling Grate Stokers

Based on the well-known fact that there is practically no variation in the weight of equal volumes of any particular coal irrespective of the size of the particles, the Republic Flow Meter Co., Chicago, Ill., has brought out a meter for use with the chain-grate stoker to measure the amount of coal fed to the furnace. The meter is an adaptation of the Lea coal meter, that has been used quite extensively in Great Britain.

The meter is designed to record automatically the product of the cross-sectional area and speed of the layer of coal passing into the furnace, the meter therefore registering the volume of the coal burned.

Fig. 1 shows a meter in position on a stoker, and a view of the interior of the meter is shown in Fig. 2. The meter is attached to the driving mechanism of the grate in such a way that the speed of the ratchet wheel *A* is varied in proportion to the grate travel. The engagement of the pawls with the ratchet wheel are in turn controlled by

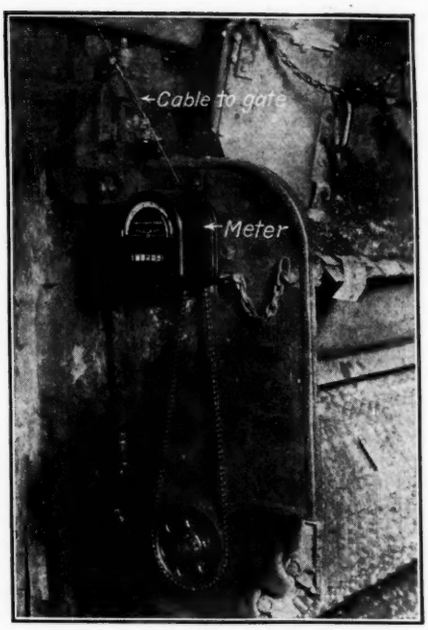


Fig. 1—Typical installation of meter

the gate opening. A cable attached to the top of the gate passes over pulleys and connects with a cam in the meter. This cam in turn throws the pawls out of contact with the ratchet wheel during a portion of a revolution, so that the number of units turned off by the counter is altered in proportion to the amount of gate opening. By multiplying the revolution of the counting wheel by a suitable constant, the weight of coal fed to the furnace is obtained.

Referring to Fig. 2, it will be seen that the meter is of sturdy construction

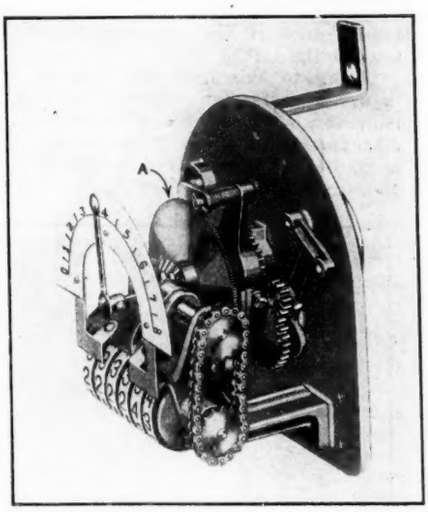


Fig. 2—View of meter mechanism

and, in addition to the counting train, is equipped with an indicating pointer to show the amount of gate opening. This feature provides a convenient means for determining the particular combination of speed and fire thickness for producing the best results.

The meter is adaptable to practically any type of traveling-grate stoker and can be placed on either side of the stoker or on the front of the boiler as desired.

Industrial Use of the Oil Engine*

By L. H. Morrison

IN RECENT years improvements in manufacturing methods have been such that production has exceeded consumption and few shops are operating at 100 per cent capacity. At the same time half of the population are going without many of the necessities of life simply because the consumer's cost is too high.

The present-day problems that must be solved before we can achieve real prosperity is that of a reduction in the cost to the ultimate consumer. Examination will reveal that the greatest obstacle to the attainment of this solution is the high cost of distribution. As long as freight rates and wages and raw materials are low in price it little matters where an object was manufactured. The larger centralized plant, by the exercise of certain inherent advantages, could manufacture far cheaper than could the small shop, and the final price was little affected by a transportation movement of a thousand or so miles.

Increasing Consumption

If consumption is to be increased not only must manufacturing cost be reduced, but of far greater importance, distribution must be accomplished more cheaply than at present. Many industrial leaders agree that to solve these problems decentralization of the factory system must take place.

By proper location of small factories in strategic points the entire country may be within a few hundred miles of the shop. Freight costs will be cut and motor-truck transportation become a fact. Owing to cheap living costs in these small towns, wages will cease to rise each year and labor disputes will largely disappear. In fact, several industries carried this plan into effect years ago, notably that of shoemaking, where a single manufacturer may have over a dozen branch factories. There is, unfortunately, a serious obstacle to the general adoption of this system.

Large Factories a Necessity

Investigation reveals that, where decentralization has become a fact, the cost of power in the particular field represents but a minute percentage in the manufacturing expense. In truth, an industry requiring a large amount of power per unit of product, under existing circumstances cannot afford to adopt the small factory plan. As long as steam power is necessary, the factory must be large, for the efficiency of the steam-power plant decreases more or less geometrically with a decrease in capacity.

It is the desirability of supplying cheap electric energy to the small factory as well as to the farm that is the basic motive for all plans of electrical interconnection. Just how much these plans will assist decentralization is difficult of gaging. There is logic in the argument that the cost of energy should be more or less based on the distance this energy must be carried, and if this be true then industry will congregate in the vicinity of the power plant where the energy will be cheapest, at a considerable distance from the center of population.

In studying the power problem of the small factory, the oil engine has been largely ignored. Owing to its particular adaptability to oil-pipe line and small central-station use its possibilities as a prime mover for industrial plants have not been appreciated even by its most enthusiastic supporters.

As a means whereby decentralization may be brought about, in so far as cheap power is concerned, the Diesel engine is well worth the closest scrutiny. While, as has been pointed out, the operating cost per unit generated in a steam plant increases rapidly with a decrease in capacity, the cost with a Diesel is practically constant regardless of capacity. The fuel consumption per horsepower-hour is the same in a 100- as in a 3,000-hp. unit; the same holds true with respect to the cost of lubrication and repairs. Whatever variation exists in the repair item is due to a difference in the character of the attendants, for it is too customary to employ the most unskilled labor in small plants from a mistaken sense of economy.

Diesel or Steam Engine

As compared to a steam plant of equal capacity one is quite safe in stating that the oil engine will always prove the more efficient, including all charges, save where much hot water, process or heating steam is needed. In these exceptions the steam plant will usually but not always prove the more economical. In many instances the installation of waste-heat boilers and the recovery of the jacket water will provide ample hot water for the factory purposes. In fact, even in plants where steam-heating requirements are high during the winter, it is not only possible but probable that the installation of an oil engine for power, with the use of steam boilers for heating, will be the most economical solution. Operated in conjunction with an exhaust-heat boiler and using the jacket water for boiler feed, the over-all efficiency of the Diesel portion of such a plant will be over 70 per cent. This is greater than the net boiler efficiency usually obtained in small plants. In fact, whenever the heating and power become unbalanced and the steam engine discharges its exhaust to the atmosphere, the oil-engine plan becomes the economical one. In other words, the oil engine would be as economical as the steam engine during the winter months, even though most of the steam heating be supplied by coal-fired boilers, and during the non-heating season its efficiency in terms of net cost per unit delivered at the switchboard would probably be twice that of the steam unit. The accuracy of these figures depends, of course, on the relative cost of coal and oil.

In the last two or three years capacities have increased to the point that units of 2,000 to 3,000 hp. are in successful operation. Several builders are prepared to construct even larger units, as the recent Shipping Board purchases prove. At least two builders are ready to supply 6,000-hp. units, while in Europe engines of 6,500-hp. capacity are in service and a 16,000-hp. 9-cylinder Diesel is in the course of construction. Since units of even 3,000 hp. fulfill the needs of 99 per cent of industrial plants, for installations of 2 to 5 engines are not impractical, lack of capacity is not an obstacle to a more extended sphere of application.

Classification of Oil Engines

In those sizes falling within what might be termed the industrial class—that is, engines of over 200-hp.—the Diesel using air for injection purposes predominates; as long as the units are held below 700 to 1,000 hp., the four-stroke-cycle holds supremacy. This is not due to any inherent advantage over the two-stroke-cycle, but is the result of unfortunate experiences with the early designs of the latter engine. Of American engines over 1,000 hp. the two-stroke-cycle is in the majority.

While four-stroke-cycle single-acting engines of 2,000 hp. are in operation, units of larger outputs must be either of the double-acting type if operating on four-stroke-cycle, or the two-stroke-cycle must be adopted.

The Solid-Injection Engine

The solid-injection engine, in which a mechanical oil pump is the sole injection agency, is the most popular unit in capacities under 300 to 400 hp. The development of this type holds peculiar interest since designers, in proceeding along three distinct lines, have arrived at almost identical solutions. A number of these cold-starting engines are the outgrowths of improvements in the semi-Diesel or hot-bulb engines. By gradually increasing compression pressures and overcoming difficulties accompanying each improvement in compression, the semi-Diesel has emerged as a true heavy-oil engine of high economy. Most of these solid-injection engines are two-stroke-cycle, and without exception these have incorporated in their design a precombustion chamber. In fact, one is quite safe in stating that some such limitation on the rate of combustion is necessary for all two-stroke-cycle engines where the scavenging and exhaust ports are in the same end of the cylinder.

Another school of designers have taken the four-stroke-cycle semi-Diesel or hot-surface engine as a foundation. Through gradual development a cold-starting engine has been evolved by a number of these designers. In all these the combustion chamber of the semi-Diesel has been retained and a thorough mixture of the air and fuel brought about either through an elongated piston or by opposing oil sprays.

The third design can be traced to the air-injection Diesel. No combustion chamber other than the engine cylinder is used. The oil spray is introduced along the cylinder axis, and mixture is brought about by first vaporizing the oil by direect impingement on the hot piston crown, followed by a diffusion

*Extract of paper read before the Chicago Section of the American Society of Mechanical Engineers, Jan. 14, 1925.

throughout the air mass. These engines are all four-stroke-cycle and may or may not be provided with mechanically actuated oil spray needles.

The economy of the solid-injection engine is equal to that of the true Diesel. By reason of its cheaper construction, brought about merely through the elimination of the costly air compressor, it will ultimately force the Diesel out of the size range between 100 and 500 horsepower.

The semi-Diesel, in point of number and horsepower, has been and still is the favorite. Being in the main of the two-stroke-cycle type, its first cost is far below that of a more economical engine. The rigid construction and simplicity of design appeal to a vast number, and as long as oil is cheap, its rather high fuel consumption is offset by its advantages for installations of 150 hp. and under. There are over 1,000,000 hp. of these engines in service.

Discussion

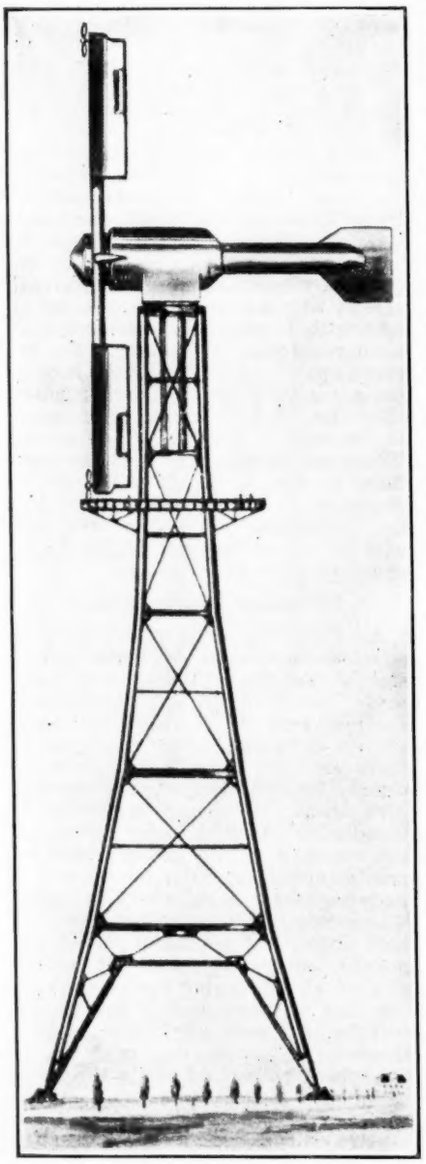
In the discussion the point was made that the cost of repairs for an oil engine extending over a term of years was seldom if ever given. That the life was short was a belief of several, although the speaker in reply pointed out that of all machines built since 1907 over 99 per cent are still in service. It was also pointed out that while parts would wear, 80 per cent of the engine cost was in the frame, flywheel or other parts having no wear. It is seldom that an engine, steam or gas, is every actually worn out; replacement is usually due to the appearance of more efficient units.

Mention was made, during the discussion, of the study made by the City of Chicago before designing certain pumping stations. Comparisons were made between the economy of different prime movers, triple-expansion engines, steam turbines, motors and Diesel engines being considered. The Diesel plant figured out close to $125 per kilowatt capacity. The Diesel engine was at a disadvantage in the r.p.m. An ordinary centrifugal pump, pumping 60,000,000 gal. against a 150-ft. head, will run at 500 r.p.m. The engine manufacturers seemed to think they could get the best results without gears. They wanted their engine direct connected to the pumps, and with that scheme, to get the 150 ft. head with the 120 r.p.m., it required a four-stage pump and a 12-ft. impeller. That is something that has never been built, and no pumping station where reliability is the first thing to be considered would take a chance on it. But taking that sort of equipment and figuring out the operating cost, the Diesel plant was about $10,000 a year more expensive than the steam-turbine plant, including interest on the investment, depreciation, labor and everything that would go into the cost of pumping that water.

A duty on a turbine plant of about 207,000,000 ft.-lb. of work per 1,000 lb. of steam at the most efficient load was guaranteed by the turbine builders. This gave the steam plant a big advantage over the Diesel plant and worked out as being the most economical for this particular plant.

Flettner Proposes Huge Wind Station

If reliance may be placed upon an account that recently appeared in a well-known German periodical, the *Frankfurter Zeitung*, this spring will see work started in Berlin on a windmill of gigantic dimensions. According to the report, which is of a popular



Whether this 650-ft. windmill is more than an artist's fancy remains to be seen.

rather than a scientific nature, the tower will rise to a height of 300 meters, or approximately 650 ft., a height not greatly inferior to that of the Woolworth Building, the world's tallest inhabited structure.

Anton Flettner, the inventor of the rotor ship described in the Dec. 30, 1924, issue of *Power*, and further discussed in the Jan. 6, 1925, issue, is the designer of this new windmill. It does not, however, make use of the Flettner rotating cylinder, but rather of wings or propeller blades designed in accordance with aërodynamical principles. Flettner is well known for the invention of his rudder, used in both ships and airplanes, which is "steered" by a small rudder at its trailing edge. As may be seen from the accompany illustration, the wings of the windmill have movable sections which may serve a similar purpose.

According to the account the cross-sections of the wings will resemble those found in airplanes. The fundamental idea underlying this cross-section is to accelerate the air velocity in order to decrease the air pressure to the minimum on the leg or rear side of the driving wing.

Aside from the mere size of the tower and the wings the most surprising thing about this whole proposal is the method of developing the power. Instead of gearing a single electric generator to the slowly turning shaft of the large wheel, it is proposed to mount a small high-speed unit windmill direct connected to a generator on the tip of each wing arm. These are shown in the sketch. It is claimed that the rotation of the large wheel will produce a tenfold wind velocity to drive the small windmills at the tips. While it is true that the speed of the small windmills will increase and decrease with that of the main wheel, it is claimed that the arrangement will permit a much closer voltage regulation. The main wheel under control of the Flettner rudder will therefore serve to obtain the most favorable operating conditions for the small wheels and at the same time to govern their output in proportion to the existing wind velocity.

The reason given for the enormous height of the tower is the desire to get up into a region of steady wind. The article in the *Frankfurter Zeitung* does not give the estimated cost of this project or the power obtainable, although these data are essential for a study of the commercial feasibility of this problem. Whether or not the proposal is a serious one, it is at least interesting.

The first turbo-generator (of the Philo Plant) was put into commercial operation October 14, 1924, with two boilers, and since that date has been carrying a fairly steady load of between 20,000 and 25,000 kw. with a steam pressure of 400 lb. The steam pressure will be gradually increased to 535 lb. in the near future. When operating under present conditions the plant economy is comparable with the most efficient plants in this country. With construction work cleaned up and the plant on a strictly operating basis, the economy will be, from present observation, considerably better than the most modern plant burning pulverized fuel—*From a recent American Gas & Electric Co. Bulletin.*

Fred B. Allard has applied to the Federal Power Commission for a preliminary permit covering an installation on Foss River in King County, Washington. The site is one hundred miles above Seattle. The power is intended for public utility use, but no estimate of the amount to be developed was submitted.

Muscle Shoals Bill Dies With Expiring Congress

Both Houses Ask President to Appoint a Commission—Norris Introduced a New Interstate Rate Plan

CONGRESS fulfilled recent expectations by adjourning March 4 without having taken constructive action on Muscle Shoals.

A resolution moved by Representative Madden and adopted by the Lower House declared it to be the sense of that body that the President should create a commission of three members to report on the "best, cheapest and most available means for the production of nitrate" at Muscle Shoals. It also was resolved "that it is the sense of the House that the value of the nitrate plants to agriculture depends upon the supply of cheap water power from the Wilson Dam, and that as a protection to the farmers this power should not be disposed of for other purposes until Congress shall have taken action upon the recommendations of the President."

At the eleventh hour on Wednesday morning the Senate passed, on the motion of Senator McKellar of Tennessee, a separate resolution for the appointment of a presidential commission, this resolution being clearly designed to support the action of the House and give it the virtual effect of a joint resolution of Congress making a request upon the President.

A resolution of this character has no legal weight. At the same time, the President has told his callers that when the House resolution reaches him he is inclined to give it a favorable reception; in other words, he intends to appoint the commission.

Its appointment will not mean, however, that the power will be allowed to run to waste. To begin with, the Sheffield steam plant is already under lease to the Alabama Power Co. at a rental of $250,000 a year and could not be affected. Moreover, the national defense act—a law in due form on the statute books—directs the sale, wherever possible, of surplus property and products. In view of the mandatory language of that statute it is not expected that the Secretary of War, the custodian of the government's Muscle Shoals properties, will allow the power to go to waste during an indefinite period during which Congress is making up its mind as to the final disposition of the property. It is therefore likely that negotiations for the temporary use of the power will be begun soon between the Secretary of War and the representatives of the associated Southern power companies.

President Coolidge in his inaugural address said that proposals for government ownership of railroads and "certain electric utilities" had met with complete defeat at the last election and pledged himself against government ownership or operation of public utilities.

Weeks Announces Provisions of Chicago Drainage Permit

Secretary Weeks has announced his decision in the Chicago Drainage case. The permit, which can be revoked at the will of the Secretary and is subject to Congressional action, holds until Dec. 31, 1929, authorized a diversion of 8,500 cu.ft.-sec. annual average. Provisions are made for the district's paying its share of restoring lake levels, for the metering of water and for sewage treatment.

Priest Rapids License Authorized

A license covering the Priest Rapids project of the Washington Irrigation and Development Co. was authorized at a meeting of the Federal Power Commission held March 2. The license covers a 750,000-hp. development in the Columbia River. The dam is to be 2½ miles long and will form a reservoir with a storage capacity of 85,000 acre-feet. The dam will be composed of an earth-fill section at each end, a concrete spillway section, a power-house section, and a concrete gravity section having fishways, an ice chute and a lock entrance to provide for possible future navigation facilities. The primary power available at the site is 201,000 hp. The initial installation will be 340,000 hp. with provision made for an ultimate installation of approximately 750,000 hp. At the instance of the Chief of Engineers the license is to carry seven conditions. These are briefly:

Licensee must submit detailed plans which become a part of the license; allowance for future navigation works by the government must be made; fish hatchery or other provision for fish must be made, costing not more than $300,000; license is subject to rights to the use of waters for irrigation purposes, and no claim for damages for diminution of water can be made; license is not to impair the rights of the Hanford Irrigation & Power Co.

Smith Predicts That Coal Will Retain Supremacy

The prediction that coal will continue to be the main source of energy and power in the United States was made by Dr. George Otis Smith, director of the United States geological survey, in an address before the Engineers' Club recently. He said water power was now nearing its highest point of development, and that it "has failed to keep pace with the advancement made by coal and oil."

One Hundred Meetings for Oil and Gas Power Week

The National Committee supervising the Oil and Gas Power Week, which is the week of April 20-25, has reported that over a hundred meetings are scheduled to be held throughout the country. Sixteen organizations are taking part in this undertaking, as announced in *Power*, Feb. 24. A recent organization to announce its participation is the American Engineering Council.

L. H. Morrison, of *Power*, will make addresses at Cincinnati, on April 24, at the Case School, Cleveland, on April 22, and at Dayton on April 25.

Oswego Has Barge Canal Power To Dispose of

The City of Oswego, N. Y., through its Water Service Commission, is canvassing the possible uses for the water power it owns at Dam No. 6, the so-called "High-Dam" of the Oswego branch of the New York State Barge Canal. This dam is on the Oswego River at the upper edge of the City of Oswego and creates a head of about 20 ft. The drainage area of the Oswego River at this point is 5,000 square miles.

The city's title to one-half of the water power at this site has been clearly established and recognized through a quit-claim deed from the State of New York. The Water Service Commission, in charge of the matter, has for its president, William J. Dowdle, and includes in its membership two engineers, Charles W. Lindsley and Homan F. Hallock. The Commission has been advised by Frank M. Williams, consulting engineer, of Albany, formerly state engineer. Recently the Commission has in addition, called in Col. F. W. Scheidenhelm, of Mead & Scheidenhelm, consulting engineers, 30 Church St., New York City, to advise what utilization or disposition of the power should be made by the city. It is reported that the Commission will welcome inquiries from prospective users of the power which is to be developed at this site.

Temple Bill Authorizing Maps Signed

The President on Feb. 27 signed the Temple bill authorizing $950,000 for the first year's work on a twenty-year program which provides for the completion of the topographic map of the United States. The entire program calls for the expenditure of $50,000,000.

Council To Be Entertained by Carolina Engineers

The Carolinas Section of the A.S.M.E. made up of the three branches at Charlotte and Raleigh, North Carolina, and Greenville, South Carolina, will join in a meeting at Charlotte on the evening of March 16 and all the following day. The A.S.M.E. Council will hold its March meeting at Charlotte on March 16, and in the evening will attend in a body a dinner meeting of the Carolinas Section.

At this meeting W. S. Lee, chairman of the Charlotte Branch, will act as toastmaster and addresses will be given by Dr. Durand and other members of the Council.

On the morning of March 17 a technical meeting of the Carolinas Section will be held at the Charlotte Hotel. This will be followed by inspection trips to hydro-electric and steam plants of the Southern Power Co., located near Charlotte.

Another Angle on Export of Canadian Power

F. W. Cowie, consulting engineer of the Montreal Harbor Commission, in a debate before the Montreal Branch of the Engineering Institute of Canada, is reported by the press as saying:

"One reason why I think it unwise to prohibit the export of power is that it is better for eastern Canada to have prosperous neighbors in New England than to see their important manufacturing industries surrender their primacy to Georgia, Tennessee, and other Southern States, which openly boast that with their cheap coal and labor, they will take New England's place in the industrial structure of America."

The most recent estimate of Canada's commercial hydro power at ordinary minimum flow was 40,000,000 hp. of which some 3,000,000 has been developed, he said. Montreal and district was now utilizing about 1,250,000 hp. Another 1,000,000 hp., which with regulation and balanced storage, would give a commercial output of 1,500,000, could be developed near Montreal at a cost of $150,000,000. Admitting the possibility of export of power under proper control, such a development would be possible in ten years, and by 1935 New England would probably be ready to take one-half of the theoretical output of 1,500,000 hp. at a price of $14 per hp. at the point of development, allowing $1 for government royalties. This power could probably be delivered in New England for $20 per hp. The big development made possible by export should permit of a price of $13 to Canadians at the point of development.

Opposing the export of power, C. J. des Baillets, chief engineer of the Montreal Water Board, argued that Canada would be weakening itself to strengthen the country across the border.

Some Powdered Fuel Plants Use 1.15 lb. per Kw.-Hr.

The Lakeside generating plant, Milwaukee, Wis., one of the first plants in the country to install powdered-fuel equipment, consumed 1.15 lb. of coal to develop one kilowatt-hour of electricity during 1924, according to John Anderson, electrical engineer in charge of its operation. It is understood that equally good performance is being obtained at the Philo station of the Ohio Power Co.

Crude-Oil Prices Expected To Advance

Another advance in crude-oil prices is expected soon, according to the daily press. The advance, which will depend upon the grade, will range between 15 and 25 cents a barrel, it is stated. Premiums of 40 and 50 cents a barrel over the current posted prices are now reported. The advance in mid-continental is expected to be followed by higher crude prices in the Wyoming, Texas, Louisiana, Eastern and other producing sections.

Bituminous Coal Exports Show Decrease in 1924

Announcement that the total exports of bituminous coal from the United States in 1924 amounted to 15,267,410 long tons, valued at $70,967,434, as compared with 19,154,981 tons in 1923, valued at $104,546,585, shows a considerable decrease in exports. Exports to Canada showed a decrease of 3,750,211 tons. The average value of exports was $4.65 a ton, a decrease from 1923, when the average value was $5.46.

Total exports of coke from the United States in 1924 were somewhat over one half those recorded in 1923.

Dispatches in the daily press state that coal dealers in London are placing orders in Alberta for coal in the expectation that freight rates are about to be reduced from $10.50 a ton to $7.

Japan Seeking Capital for Power Plants

Renewed activity in developing the water-power resources of Japan is seen in the recent announcement by Jerome D. Greene, Vancouver, B. C., whose firm, Lee & Higginson & Co. in Japan, has been conducting negotiations with New York concerns leading to a loan of $45,000,000 to three Japanese hydro-electric companies. No details are available concerning the contemplated projects further than the name of the three companies, which are: The Toho Hydro-Electric Co., the Ushigawa Hydro-Electric Co., and the Daido Electric Co., the last-named a holding company for numerous steam and electric companies. Japan is rich in water power, having many rivers whose resources have not begun to be utilized.

As reported in *Power*, Feb. 10, orders for two 35,000-kw. 11,000-volt 50-cycle turbine generators have been placed with the International General Electric Co. by the Hayakawa Electric Power Co., a subsidiary of the Toho Electric Power Co., which serves power to Tokyo, at a cost of $2,000,000.

This equipment will be used in parallel with the company's hydro-electric Hamamatsu station.

Diesel for Emergency Fleet Ship Sold to Ford Co.

According to New York newspapers, the Ford Co., of Detroit, bought on Feb. 26 the "East Indian," a twin-screw steel cargo ship of 11,679 tons from the Fleet Corporation. It was stipulated, so the report runs, that the purchaser would convert the vessel to Diesel propulsion. Acquisition of this ship by the Ford company is regarded in Shipping Board circles as the forerunner of a number of sales of government tonnage, out of which the Detroit manufacturer will eventually build up his own fleet. Gibbs Brothers, naval architects, of New York, have been engaged to recondition the "East Indian" and install the Diesel drive and other auxiliaries. When reconditioned, the ship will be placed in the trans-Atlantic service of the company, it is reported.

Detroit Municipal Plant Progress

Owing to the limitations imposed by the city charter, the selection and purchase of equipment for the Morrel Street station of the City of Detroit has progressed rather slowly. *Power* has already published the bids for boilers, turbines and condensers. According to the statement of L. J. Schrenk, assistant superintendent, appearing in the *Bulletin* of the Associated Technical Societies of Detroit, contracts have now been let for the pulverizing equipment, fuel-burning equipment, coal-handling machinery, economizers and air preheaters.

Powdered coal was selected not because it showed a decided efficiency over stokers, but because of its flexibility in burning efficiently coal of various qualities such as are likely to be received in Detroit.

Water walls will be employed to cover the greater part of the furnace sides and the lower half of the rear wall. These together with the slag screens will be connected with the cross-drum of the boiler and receive circulating water in the same manner as the boiler tubes. The front portion of the side walls and the front furnace wall will be of hollow construction through which preheated air will be furnished. The air preheater will be of the parallel-plate type

With a view to obtaining a uniform superheat, both the convection and radiant type of superheaters will be employed.

The economizers will be of the two-pass type with cast steel headers and seamless steel tubes, lead coated both inside and out in order to eliminate the corrosive and abrasive action of the gases as well as internal pitting.

It will be recalled that the initial installation will be for 60,000 kw. with steam at 400 lb. pressure and 725 deg. total temperature.

Federal Arbitration Bill Signed by President

The Sterling-Mills Federal Commercial Arbitration Bill was signed by the President on Feb. 12. This bill gives arbitration of matters normally coming before the Federal Courts, the same status that arbitration now has in New York and New Jersey. This is an important step forward in the effort to settle commercial disputes at a great saving of time and at a much lower cost to all parties.

Service Emblems Presented to Employees

Diamond service emblems have been presented by the American Engineering Co., Philadelphia, to 32 of its employees who have been with the company for 25 years or more. Gold medals were presented to 275 other employees with records of 5 to 25 years service. Among those receiving the diamond medals were two machinists with records of 46 and 45 years active service. Both are still employed daily in the shops of the company.

Another Merger of Power Companies in Ohio

Purchase of the Dayton Power & Light Co. by the Columbia Gas & Electric Co., a holding company for utilities in Ohio, Kentucky and Virginia is an important step in the centralization of all the electric light, power and gas facilities in the Miami Valley which takes in a large industrial district. The Dayton Power & Light Co. supplies a large part of the power through the Miami Valley; the Columbia Gas & Electric Co. holds large natural gas resources. The grouped properties will have a generating capacity of 434,000 hp. it is stated. Belonging to the group is the new Miami Fort power station described in *Power* Dec. 30.

Portland (Ore.) Utility To Change Ownership

The American Power & Light Co., one of the Electric Bond & Share companies, has purchased the entire outstanding common stock of the Northwestern Electric Co. operating in and around Portland, Ore. Management and operation of the Northwestern properties will be under the control of the Pacific Power & Light Co. and will remain as it is for the present.

With the amalgamation of the systems the transmission lines of the Northwestern company, already tied in with those of the Pacific company at Hood River, Ore., will be connected with the latter's transmission network in eastern Washington and Oregon. The construction of this line and the development of a major power site on either the Lewis or the Deschutes River will be among the early undertakings of the combined systems. This merger brings the Pacific Power & Light Co. into the light and power field in the City of Portland, and adds 15,000 kw. in hydro-electric and 25,000 kw. in steam capacity to the Pacific system.

Fuel Oil in New York Discussed

"The Application of Oil-Burning Power Plants to Office and Merchantile Buildings in New York," formed the subject of a paper by Andrew W. Coyle, before the Metropolitan Section of the A.S.M.E. and the New York Chapter of the A.S.H. & V.E., on Tuesday evening, March 3.

The speaker showed that in all there are about 300 fuel-oil installations of all kinds within the Metropolitan area, which include a number of prominent office buildings, several hotels, hospitals, department stores, etc. The majority of these buildings changed over to oil three or four years ago at the time when the coal situation was acute and an abundant supply of fuel oil at an attractive price was obtainable. Since then the price of fuel oil has advanced and that of coal decreased and the coal supply has become more stabilized. Thus the margin in favor of fuel oil has become less and less, and with the prospect of still higher prices for fuel oil and the impossibility of securing a long-term contract, the balance may, in the near future, revert in favor of coal. In spite of this, however, several new buildings in the city have recently been equipped with fuel oil. Among these may be mentioned the Federal Reserve Bank, the Pershing Square Building, the new Equitable Building and the new office building of the Brooklyn Edison Co.

Mr. Coyle reviewed and illustrated the installations in several of the more important buildings and dealt particularly with the installation in the Singer Building, which was the pioneer in fuel-oil burning in New York City. At the time this change-over was made, there was no well-defined local ordinance covering the storage of fuel oil, and with the authority divided between the Building Department and the Fire Department many difficulties were encountered. These have now largely disappeared, although there is still a difference of opinion with regard to the space between the storage tanks and the surrounding compartment. The insurance companies insist that this space be filled with sand, whereas the Fire Department insists that it be left open. The latter practice has the advantage that it will disclose any leak that may occur.

Another building that Mr. Coyle discussed was that of R. H. Macy & Co., one of the largest private power plants in the city, which has ten boilers aggregating 30,000 sq.ft. and an electrical load running as high as 30,000 kw.-hr. per day. The electrical load for 1924 was 69.9 per cent greater than in 1922, when coal was burned, yet the fuel bill during the later period was $300 less than that of the earlier year. Of course, part of this is accounted for in that coal cost $6.75 per ton in 1922.

In discussing Mr. Coyle's paper, Mr. Christie, of the Standard Oil Co., pointed out that New York City is dependent mostly for its fuel oil on Mexico and because of the tax by the Mexican Government the prospects are that the prices will advance rather than decrease in the immediate future.

New England Water Works Association To Cruise

The New England Water Works Association will hold its forty-fourth annual convention on board the S. S. "Richelieu" of the Canadian Steamship lines, Sept. 8-11. The tour will include a trip from the Thousand Islands to Montreal. Upon arrival at Montreal, immediate transfer will be made to the "Richelieu" and the cruise of four and one-half days on the St. Lawrence and Saguenay Rivers will begin. The itinerary and tours are under the management of George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Hydro-Electric Plant To Be Erected in Java

A 30,000-hp. hydro-electric plant, with transmission lines to numerous industrial and agricultural centers, is soon to be built near the City of Soerabaya, according to a report from vice consul Rollin R. Winslow, published in *Commerce Reports*. It is anticipated that the construction work will be started about the middle of this year. Details of the type of equipment desired have not been obtained, but American manufacturers interested in further particulars regarding the location, ownership and capitalization of the plant may obtain this information on loan by writing the electrical equipment division, Bureau of Foreign and Domestic Commerce, Washington, D. C., and referring to No. 154737.

Amalgam Briquets Being Made for Domestic Use

There are some fifteen plants around the country that are producing briquets for fuel, it is stated. The output now runs around half a million tons a year. It must be said, however, that the market for briquets has been disappointingly small. It apparently has not been possible to market a product at much less than the price level of lump coal. The prevailing types of briquets have had two disadvantages. They have had a high ash content and have been productive of smoke.

There now appears a solid fuel which promises to overcome both these handicaps. F. R. Wadleigh, the former Federal Fuel Distributor, has become the active head of a corporation which is using the Trent amalgam process to eliminate the ash.

The method of making the amalgam is now familiar. The coal is pulverized and mixed with oil and water. The ash tends to pass off with the water, while the oil and the coal stick together in a pasty mass in the form of little pellets. Under a more recent development the amalgam is pressed through dies into pieces of cylindrical shape which then are baked. This drives off the excess oil, leaving a hard clean product which is the low ash.

The manufacture of briquets by this process has not been undertaken as yet on a large commercial scale, but the sample lots that have been distributed widely for study and observation have been tried with excellent results.

A.S.M.E. Spring Meeting Plans Under Way

The technical program of the A.S.M.E. Spring Meeting, which is to be held at Milwaukee, from May 18 at 21, is nearing completion. Technical sessions are scheduled for the mornings, the afternoons will be devoted to excursions and the evenings to entertainments.

A feature of one evening will be a session devoted to matters of engineering interest in Milwaukee at which there will be a valuable study of the "Economic Advantage of Cities Having Diversified Industries," "Mechanical Engineering Problems of Sewage-Disposal Plants," and a "Discussion of the New Riverside Pumping Station at Milwaukee."

The Materials Handling Division will at one session take up the important work which it is doing in deriving standard formulas for evaluating labor-saving equipment, and the applications of the formulas will be discussed.

The Power sessions will furnish a strong combination of papers; the Fuels sessions will be devoted to pulverized coal; the Hydraulic sessions will take up the operation and design of hydraulic plants and the joint operation of steam and hydro-electric plants; the Oil and Gas Power sessions will discuss important design problems. There will be a diversity of topics at the Steam Power sessions; papers will be presented on steam turbines, steam-pipe insulation, unaflow engines and heat balance.

Coal Dust Annoyance Solved by New Smokestack

Completion of a new 216-ft. 18 ft. dia., concrete smokestack and the putting of it into operation at the Atlantic City Electric Co.'s power plant has brought to an end the annoying nuisance under which the plant had been suffering for two years, according to an article by George M. Leach in the American Gas & Electric Co., Bulletin.

When two 1,900-hp. boilers of latest design were installed in the plant in 1922, it was decided that the greatest efficiency could be obtained by equipping each boiler with a shorter individual stack and by the installation of powerful motor-driven blowers in the base of each stack to provide the "induced draft" necessary to obtain maximum capacity. It was soon found, however, that these induced-draft blowers caused the boiler gases to flow upward through the stacks with such a high velocity that many fine particles of unburned coal were also carried along and, at times of high winds, were distributed over a considerable area. Many plans for overcoming this condition were unsuccessfully tried. Finally, it was decided to construct one large stack for both boilers, which would permit the induced-draft blowers to be operated at a much lower speed with consequent lower velocity of the stack gases, and the fine particles of coal, instead of being carried up and distributed over the landscape, would drop into the base of the stack when they might be reburned or otherwise ndisposed of.

University Engineers To Hold Open House

The engineering students and faculty of Washington University, St. Louis, Mo., are holding open house on March 13. Each department of the engineering school has exhibitions of various kinds, including laboratory equipment such as engines, motors, generators.

Columbia River Basin Report Not Satisfactory

What is regarded, in official quarters, as an unsatisfactory report on the Columbia Basin project has been submitted by the special Board of Engineers. Five plans are set up with the idea that the Interior Department Commission, consisting of Elwood Mead and Francis M. Goodwin, will select the one it chooses to recommend to the Secretary of the Interior.

The report is incomplete to the extent that it does not indicate the average cost per acre. No estimate is made as to the number of farms, the cost of the land, or the cost of farm development. Such estimates are held to be just as necessary as data in regard to engineering costs. The consensus of opinion seems to be that additional data must be submitted.

Hydro-Electric Conference in Philadelphia March 10

The Third Hydro-Electric Conference under the auspices of the Philadelphia Engineers Club will be held in Philadelphia on March 10.

The morning and afternoon sessions will be held in the auditorium of the Manufacturers Club. In the evening there will be a dinner meeting at the Bellevue-Stratford. Dr. William F. Durand, president of the A.S.M.E., will speak on "Power and Its Relation to American Progress"; Henry L. Harriman, president of the New England Power Co., on "Water Power's and Superpower's Contribution to New England"; Charles Penrose, assistant general manager of Day and Zimmermann, Inc., "Power in Pennsyvania."

Papers at the morning and afternoon sessions include the following: "Operation of Hydro-Electric Systems and Auxiliary Steam Plants for Best Economy and Proper Governing," by W. M. White, of the Allis-Chalmers Manufacturing Co.; "Operation of Hydro-Electric Units for Maximum Kilowatt-Hours," by Forest Nagler, Allis-Chalmers Manufacturing Co.; "Inter-Relation of Operation and Design of Hydraulic Turbines," by Frank H. Rogers and Lewis F. Moody of William Cramp & Sons Ship & Engine Building Co.; "Operating Problems and Their Relation to the Design of Hydro-Electric Machinery in the West," by Ely C. Hutchinson, Pelton Water-Wheel Co.; "Operating Practices in Hydro-Electric Plants," by Charles B. Hawley, consulting engineers, Washington, D. C.; "Features of Design in Latest Large Hydro-Electric Generators," by M. C. Olson, General Electric Co.; "Recent Developments in Hydro-Electric Generators," by F. D. Newbury, Westinghouse Electric & Manufacturing Co.

Personal Mention

R. C. L. Greer, formerly resident engineer of the East Penn Electric Co., Pottsville, Pa., has been appointed general superintendent of the Portsmouth (N. H.) Power Co.

Minouru Fukuda, chief engineer of the Toho (Japan) Electric Power Co., is now in this country and has been visiting the Schenectady plant of the General Electric Co.

Dr. Arthur D. Little, a well known Boston research and chemical engineer, has been elected to the chairmanship of the Exposition of Chemical Industries, which is to be held in the Grand Central Palace, New York City, Sept. 28.

Frank E. Snyder, of Montgomery, Minn., has been chosen by the Owatonna (Minn.) Public Utilities Commission as superintendent of the new municipal lighting, power and central heating plant to be put in operation in the spring.

L. H. McCray, who recently resigned as assistant general manager of the East Penn Electric Co., Pottsville, Pa., is now manager of the Portsmouth (N. H.) Power Co. and the Kittery Electric Light Co.

Obituary

Robert McF. Double, formerly connected with the Central Colorado Power Co. and for eighteen years a resident of Denver, Colo., died at San Francisco, Feb. 14, in his sixtieth year. Mr. Double, during his association with the Central Colorado organization, designed some of its hydro-electric plants.

William R. McClave, general manager, secretary and treasurer of the McClave-Brooks Manufacturing Co., of Scranton, Pa., died at his home in Scranton, on Feb. 16, following a protracted illness. Mr. McClave was born in Carbondale 59 years ago, but removed to Scranton at an early age. He has been associated with the McClave-Brooks company since its founding in 1883 by his father, William McClave. Among the many clubs to which he belonged were the Engineers' Club of New York City, Engineers' Society of Northeastern Pennsylvania and Manufacturers Club of Philadelphia. He is survived by his father, William McClave, one daughter, Mrs. Harvey T. Warren, and one son, R. B. McClave.

Edward H. Raymond, vice-president of the Crane Co., Chicago, Ill., died suddenly on Feb. 24 while in his berth on a Texas and Pacific train, traveling from Texas to New Orleans, in company with C. D. Little, general sales manager of the company. He had been in the best of health apparently when he started on the trip. Mr. Raymond was born in Elgin, Ill., Aug. 27, 1864, and became associated with the Crane Co. in 1890 as traveling salesman and since that time has been advanced to his present position. In a business way and socially Mr. Raymond had a host of friends. He had a strong personality, was a hard worker and most resourceful. He is survived by his widow, two brothers and two sisters.

Society Affairs

The Erie Section of the A.S.M.E. will have W. C. Heckeroth, Erie City Iron Works, speak on "Powdered Coal," at its March 10 meeting.

The Erie Section of the A.I.E.E. will have A. A. Buck, General Electric Co., speak on "Patents and Inventions," at its March 17 meeting.

The Rochester Section of the A.S.M.E. will hear, on March 13, Walter Keenan, Thomas E. Murray, Inc., speak on "Tendencies in Design of Modern Power Plants."

The Waterbury (Conn.) Section of the A.S.M.E. will hear Dr. William F. Durand, president of the A.S.M.E., speak on "The Engineering Profession —Its Antiquity and Its Obligations," at its March 13 meeting, which will be held in the Chamber of Commerce Hall.

The American Society for Testing Materials will hold a three-day session for Metals Group meetings at the Bellevue-Stratford Hotel, Philadelphia, on March 18-20 On Tuesday morning J. H. Gibboney, chairman, Committee A-5 will hold a session on "Corrosion of Iron and Steel," and Friday, Committee B-3 will hold a meeting devoted to "Corrosion of Non-Ferrous Metals and Alloys."

The New England Water Works Association will hold a luncheon meeting at the Boston City Club, on Mar. 10. Papers will be read as follows: "The Diesel Engine and Its Overall Efficiency," by C. B. Jahnke, chief engineer of Fairbanks, Morse & Co.; "Diesel Engine Experience in a Pumping Plant," by Leonard C. Smith, consulting engineer, Long Island City; "Diesel Engine Experience in a Modern Forge Plant," by J. P. Harbeson, Jr., chief engineer, Camden Forge Co.

Business Notes

Acers-Poppenhusen is the name of a new firm composed of P. Albert Poppenhusen, formerly president of the Green Engineering Co., Ralph C. Acers and Earl A. Acers. The new firm will represent The Engineer Co., "Proco" products and other companies manufacturing power-plant equipment, and will be at 622 McCormick Bldg., Chicago.

The Hahn Engineering Co., Twentieth St. & Indiana Ave., Philadelphia, Pa., is a new firm recently organized by Eugene Hahn, formerly chief engineer of the Victor Engineering Co., Bullitt Bldg., Philadelphia, for the manufacture and sale of jet conveyors and ejectors for ashes, soot, coke and kindred materials as well as sectional cast-iron tanks.

The DeLaval Steam Turbine Co., Trenton, N. J., announces that as of Jan. 15, all products of the company, as well as all products of the De Laval Separator Co., Poughkeepsie, N. Y., will be handled exclusively by the Turbine Equipment Co. in the New England territory. F. R. C. Boyd, formerly connected with the Power Equipment Co., is president of the Turbine Equipment Co. and will handle the business from offices at 80 Federal St., Boston, Mass.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Convention at Orlando, Fla., June 2-5.

American Association of Oil Burner Manufacturers. Leod D. Becker, Bank of Galesburg Bldg., Galesburg, Ill. Convention and exhibit at Edgewater Beach Hotel, Chicago, April 1-3.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Niagara Falls, April 23-25.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at St. Louis, April 13-17. Annual convention at Saratoga Springs, June 22-26.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Water Works Association. W. N. Niesley, 170 Broadway, New York City. Convention at Louisville, Apr. 27-May 3.

Canadian Association of Stationary Engineers. Geo. J. Soucy, 48 Moore Ave., Toronto, Ont., Secy. Convention at Windsor, June 29-July 1.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Indiana State Association** at Purdue University, Lafayette, Ind., April 20-23. W. C. Knowles, Northern Indiana Gas & Electric Co., Lafayette, Ind. **Kansas Association** at Topeka, May 6-8. J. M. Van Sant 739 Horne St., Topeka. **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 10-12, formerly announced June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Trade Catalogs

Pumps, Sump—Taber Pump Co., Buffalo, N. Y. Bulletin No. 120-A describes the standard vertical centrifugal and sump pumps manufactured by this company. Rating and dimension tables, illustrations of pumps, etc. are included.

Valve Rims—The Babbitt Steam Specialty Co., New Bedford, Mass. Leaflet describing the adjustable sprocket rim with chain guide manufactured by this company has just been issued. Illustrations, covering the installation and operations of these rims and a table of sizes, are included.

Boilers—The McAleenan Corp., Pittsburgh, Pa. Catalog No. 4 is a recent publication describing the water-tube boilers manufactured by this company. The catalog, besides good descriptions and drawings of inclined and horizontal types and small boilers for industrial plants, has photos of installations and boiler settings in course of construction.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	Mar. 2, 1925
Pool 1	New York	$2.50@$2.85
Smokeless	Boston	1.61
Clearfield	Boston	1.75@ 2.35
Somerset	Boston	1.85@ 2.25
Kanawha	Columbus	1.40@ 1.60
Hocking	Columbus	1.35@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas/ slack	Pittsburgh	1.25@ 1.35
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.25@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	$2.00@$3.15
Buckwheat No. 1.	Philadelphia	2.25@ 3.00
Birdseye	New York	1.35@ 1.60

FUEL OIL

New York—Mar. 5, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 24, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.15 per bbl.; 26@28 deg., $2.20 per bbl.; 28@30 deg., $2.25 per bbl.; 30@32 deg., $2.30 per bbl.; 32@36 deg., gas oil, 6c. per gal.; 38@40 deg., 7c. per gal.

Pittsburgh—Mar. 3, f.o.b. local refinery; 30@34 deg. fuel oil, 6½c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Dallas—Mar. 3, f.o.b. local refinery, 26@30 deg., $1.90 per bbl.

Philadelphia—Feb. 25, 28@30 deg., $2.73@$2.793 per bbl.; 18@22 deg., $2.42@$2.483; 13@16 deg., $2.10@ $2.163 per bbl.

Boston—Mar. 2, tank-car lots, f.o.b.; heavy oil, 12@14 deg., Baumé, 4 9/10c. per gal.; light oil, 28@32 deg. Baumé, 6c. per gal.

Cincinnati—Mar. 3, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

New Plant Construction

Calif., Beverly Hills—Beverly Hills Ice Co., awarded contract for the construction of an 82 x 175 ft. ice plant to J. N. Cooper, Marsh-Strong Bldg., Los Angeles, Archt., on the cost plus basis.

Calif., Berkeley—Central Berkeley Building Co., Inc., c/o W. H. Ratcliffe, Jr., Mercantile Bank Bldg., Archt. is having preliminary plans prepared for the construction of a 6 story office and stores building, at Center St. and Shattuck Ave. Estimated cost $500,000.

Calif., Blythe—City, will receive bids until March 16th for the construction of sewage system and pumping station, Burns-McDonnell-Smith Engineering Co., Marsh-Strong Bldg., Los Angeles is engineer.

Calif., Gustine—City, plans an election to vote $15,000 bonds for the construction of a new water tank and improvements to pumping equipment and mains. Total estimated cost $15,000.

Calif., San Francisco—Whitcomb Hotel, Market and Eighth Sts., is having preliminary plans prepared for the construction of a 7-story hotel annex. Estimated cost $500,000. G. Ruchforth, 254 Pine St., is architect.

Calif., Santa Barbara—City, voted $140,000 bonds, for the construction of a hydro-electric power plant, and distributing system. G. Morrison, is city engineer.

Calif., Santa Barbara—H. H. Henderson, Mihran Bldg., et. al., plan the construction of irrigation works, including power plants, reservoirs, dams, etc. Estimated cost $2,000,000.

Conn., Bridgeport — American Tube & Stamping Co., 766 Stratford Ave., will build a 5 unit plant on Stratford Ave. by day labor. The plans include 30 x 43 ft. power house, 30 x 36 ft. factory, and three, 9 x 40 ft., 11 x 94 ft. and 13 x 60 ft. switch buildings. Estimated cost $50,000. Equipment will be required. Private plans.

Fla., Tallahassee—W. R. Galt, City Manager, will receive bids until March 17th, for a single stage, centrifugal pump, 4 in. suction, 3 in. discharge, capacity 300 g.p.m. direct connected to a.c. motor, 220 v. 3 phase, 60 cyc. equipped with open type impeller suitable for handling sewerage.

Fla., Tampa—Strand Amusement Co., W. B. Gray, Pres., 101 Memorial Bldg. plans the construction of a 15 story, office and theater building, on recently purchased site, at Franklin and Polk Sts. Estimated cost $600,000.

La., New Orleans — Weiss & Dreyfous, Maison Bldg., Archts., will receive bids until March 15th for the construction of a 10 story hotel, at Canal and Howard Sts., for P. Jung and others. Estimated cost $1,000,000. High speed electric freight and passenger elevators will be required.

La., Thibodaux—Thibodaux Ice and Manufacturing Co., plans the installation of a modern raw water unit, in ice plant. P. R. Percy is president.

Ill., Chicago—Stevens Hotel, c/o Holabird and Roche, 104 South Michigan Ave., Archts. and Engrs. will receive bids until March 17th for the construction of a 25 story hotel building, on Michigan Blvd., near 7th St.

Me., Augusta—H. J. Tetreault, 45 Middle St., will soon receive bids for the construction of a 6 story, hotel addition. Estimated cost $500,000. Bunker & Savage, Augusta Trust Bldg. are architects.

Me., Rumford — Community Hospital, E. W. McCathey, is receiving bids for the construction of a nurses home, and power house. Estimated cost $150,000. Power house equipment will be required. Rogers & Dion, 142 Berkeley St., Boston, are architects.

Mass., Fort Warren—Office of the Quartermaster, Boston Harbor, L. Bullock, Capt., will receive bids until March 22nd for the installation of terminating current substation equipment, at Fort Warren and Fort Strong, Boston Harbor. Spec. 400.151 Boston Harbor.

Mass., Lowell—Wamfsit Power Co., Glidden Bldg. awarded contract for the design and construction of a power house to Stone and Webster, Inc., 147 Milk St., Boston. Estimated cost $1,000,000.

Mass., Medford—M. A. Dyer, 1 Beacon St., Boston, Archt., is preparing plans for the construction of a 6 story apartment house, on High St. Estimated cost $500,000. Owner's name withheld.

Mass., Springfield—Bridgeway Hotel Corporation, Bridge St., c/o H. M. Stanford, is having plans prepared for the construction of a 10 story, hotel addition at Bridge St. Estimated cost $1,000,000. Huestis & Heustis, 154 Chestnut St., are architects.

Mass., Springfield—Cooley Hotel Co. c/o C. T. & A. J. Shean, plans the construction of a hotel addition at Main and Liberty Sts. Estimated cost $1,000,000. A. H. LaValle, 293 Bridge St., is architect.

Minn., Hibbing—City J. L. Golob, recorder, will receive bids until March 16th for the construction of an addition to the municipal steam heating and power plant, and installation of additional equipment, including 2,500 kw. steam turbine, 2,000 hp. boiler, coal handling equipment, stokers, stack, etc. Estimated cost $300,000. R. D. Thomas, 1200 Second Ave., Minneapolis, is engineer.

Mo., Fredericktown—City will soon award contract for the construction of water works improvements, including pumping equipment, tank on tower, distribution mains, etc. Estimated cost $112,000. C. A. Haskins, 517 Finance Bldg. is engineer.

Mo., Kansas City—Park Lane Syndicate, plans the construction of a 5 story hotel at 46th St. and Mill Creek Parkway. Estimated cost $850,000. G. B. Post & Sons, are architects.

Mo., St. Louis—Knights of Pythias, c/o St. Louis Lodge Deputies Assn, plans the construction of a 10 story office building, with lodge rooms, swimming pool, etc. on Grand near Olive Sts. Estimated cost $1,000,000. Engineer and architect not selected.

Mo., St. Louis—Puritan Oil Corporation, 35 West Ferry St., plans the construction of a 10-story office building on site recently acquired at Washington and Theresa Aves. Estimated cost $500,000.

Neb., Ulysses—City, P. H. Toby, Clk. voted $10,000 bonds for construction of pump house, with pump and motor, 50,000 gal. tank on tower, 150 ft. well, etc.

N. J., Asbury Park—Berkley—Cartaret Hotel c/o Warren & Wetmore, 16 East 47th St., New York City, Archts., is having plans prepared for the construction of a hotel, including steam heating system. here. Estimated cost $1,250,000.

N. J., Cape May—Bd. of Commissioners, G. P. Wentzell, Chrm., will receive bids until March 12th for the furnishing and installation of fuel oil pumping and air lift machinery, at the city water works. H. W. Bell is city engineer.

N. Y., New York—National Board of Fire Underwriters, 76 William St., is having plans prepared for the construction of a 14 story office building, including steam heating system, at John and Gold Sts. Estimated cost $1,150,000. Clinton & Russell, 106 Maiden Lane, are engineers and architects.

N. C., Chimney Rock—Chimney Rock Mountains, Inc., awarded contract for the construction of a dam and power plant on Rocky Broad River, 13,500,000 kw. capacity per annum, to J. A. Gardner, 211½ North Tyron St. Charlotte, about $675,000.

O., Baltimore—The Fanfield Paper Co. awarded contract for the construction of a factory and power house, to H. K. Ferguson Co., 4900 Euclid Ave., Cleveland. Estimated cost $100,000. Private plans.

O., Cleveland—City, A. K. Hoare, Pur. Agt., is in the market for one 60 m.g.h., steam turbine, reduction gear driven centrifugal pumping unit for Kirtland Pumping Station.

O., Lakewood (Cleveland P. O.)—Bd. of Education, G. W. Grill, Clk., 1456 Warren Rd., is in the market for an electric mixing machine, and refrigerating machine.

O., Zanesville—Ohio Ice Co., L. L. Schofield, Mgr., is in the market for ice manufacturing equipment for new plant.

Okla., Elk City—City has had preliminary plans prepared for additions to distribution system, including reservoir, mains, pumps, mains, etc. Estimated cost $30,000. Engineer not selected.

Okla., Oklahoma City— A. C. Kraipke, Herskowitz Bldg., awarded contract for the construction of an 8 story apartment house at 13th and Shartel Sts., to Kriepke-Schaefer Construction Co., Herskowitz Bldg. Estimated cost $700,000.

Okla., Perry—City will receive bids until March 11 for equipment for electric light plant, including generator panel or switchboard, 225 kw. capacity; 300 to 350 hp. Diesel oil engine, with 3 phase 60 cyc. 2,300 v. generator.

Pa., Philadelphia—Seventeenth and Walnut St. Corporation, c/o L. B. Rothschild, 215 South Broad St., awarded contract for the construction of a 12 story stores and office building, at Seventeenth and Walnut Sts., to J. E. Dever, Ridley Park. Estimated cost $500,000.

S. C., Spartanburg — Commissioners of Public Wks., Water Works office, D. W. Hendrix, Chm., will receive bids until April 14 for new water supply system, including power house with generators, turbines, and pumping equipment; water purification plant, 6 m.g.d. capacity; reservoir, dam, etc. R. B. Simms is superintendent of Water Works.

Tex., Danna—City, W. Whigham, mayor, voted $50,000 bonds for waterworks improvements, including mains, pumping equipment, wells, etc. Engineer not selected.

Tex., Dilley—City is having plans prepared for the waterworks improvements, including distribution system, 50,000 gal. capacity elevated tank, pumping equipment, etc. Estimated cost $30,000. Terrell Bartlett Engineers, 612 Calcauieu Bldg., are engineers.

Tex., Giddings—City, J. D. Fields, mayor, voted $46,000 bonds for waterworks improvements, including mains and additional pumping equipment.

Tex., Jayton—City voted $50,000 bonds for new waterworks system, including pumping equipment, wells, mains, etc. Montgomery & Ward, City National Bank Bldg., Wichita Falls, are engineers.

Tex., Lometa—City will hold an election on March 15th to vote $42,000 bonds for waterworks, including drilling 2 wells and purchasing pumping equipment. Engineer not selected.

Tex., O'Donnell—City plans election to vote $100,000 bonds for waterworks improvements, including pumping equipment, mains, etc. Lynn Company is engineer.

Tex., Rusk—City, F. A. Jones, Engr., is receiving bids for the construction of an earth dam, spillway, filtration plant, pumping plant, extension of mains, etc.

Tex., Victoria—City, c/o S. S. Sitterle, is taking bids for the construction of an addition to boiler house, including smokestack and two 6 x 18 ft. boilers. Estimated cost 30,000. W. E. Le Noue, Texas State Bank Bldg., San Antonio, is engineer.

Tex., Weslaco—City voted $20,000 bonds for water works improvements, including pumping equipment and mains, Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Wash., Yale—Northwestern Electric Co., Portland, Ore., L. T. Merssin, Gen. Mgr., will receive bids about May 1st., for hydro-electric development, on the Lewis River, near here, including dam, power line, electrical equipment, and plant developing 40,000 hp. $1,500,000 will be expended in 1925, total estimated cost $5,000,000. Company engineers in charge.

Ont., Erin—Deagle Bros. plan to equip a water power plant and are interested in prices on equipment. Estimated cost $35,000.

Ont., Perry Township—Council has requested the Ontario Hydro Power Commission, A. Beck, Chn., to report on the possibilities of utilizing Brooks Falls, for supplying power for electric light and power plant for the district.

Ont., Waterford—City Council, will receive bids about April 1, for the construction of a waterworks system, with equipment including mains, pumps, etc. Estimated cost $50,000. C. C. Fairchilds, 169 Colborne St., Brantford, is engineer.

Que., Quebec City—City has had plans prepared for two 5,000 g.p.m. pumps, 120 ft., head. F. C. Laberge, Montreal, is engineer.

N. Z., Wellington—New Zealand Government Railways, Railway Board, will receive bids until April 28, for furnishing 65 a.c. electric motors.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

The price situation in power plant supplies is one in which advances about balance the declines. The rises, however, were confined mostly to steel products. Declines occurred in wiping cloths, linseed oil, cement and non-ferrous metals. Machine and engine lubricants are reported firmer with no conspicuous price changes. The most notable increase occurred in the price of rivets. Boiler rivets are now $4.60 per 100 lb. at New York warehouses, against $4.35, one month ago.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection 50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket	56c. per ft.
Common, 2½-in., cotton-rubber lined, 80c. per ft. list less	45%

Air—Best grade

¾-in., per ft.	3-ply $0 33	4 ply	$0.40

Steam—Discounts from List

First grade	40%	Second grade	40-5%	Third grade	40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50-5%	Second grade	50-10-5%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40-2½%
Heavy	30-5%

RAWHIDE LACING
For cut, best grade, 45-5%, 2nd grade, 55%.
For laces in sides, best, 41c. per sq.ft.; 2nd, 37c.
Semi-tanned: cut, 45-5%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15@22	19.00	.14@.16
Colored	10.00@15.50	18.00	.09½@.12½

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13¼ x 13¼	13¼ x 20½
Chicago	11.00	11.00
New York (white, at washeries)	9.50	
Cleveland	$36.00 per M.	$50.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.21	$1.32	$1.25

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	16.25	14.00	17.75	15.50
White	16.25	14.00	16.25	14.00

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, ⅛x1-in. and longer, 19c. per lb., less 60% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ¾-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$4.50	Chicago	$3.50	Pittsburgh	$2.50@2.60

Boiler rivets, same sizes:

New York	$4.60	Chicago	$3.70	Pittsburgh	$2.85@2.90

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$47@52
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	22@27
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	26@31
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Chrome ore crude, 40@50%	net ton	18.00@19.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	67.50	50.00
(35% tin)	28.00	21.50	28.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$4.00	$3.80
Flats, squares and hexagons, per 100 lb. base	4.65	4.50	4.30

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
2	.20	.25	.21
2¼	.23	.29	.23
2½	.24	.33	.28
2¾	....	....	....
3	.30	41	.32
3½	.32	.47	.35
3½	.34	.51	.37
4	.43	.64	.47

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1½ in. to 2 in. diameter, 5c. per cut. 2¼ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$39.00 (net)	$ 53.50 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:	Lead Covered
Less than coil lots	50% 25%
Coils to 1,000 ft.	55% 30%
1,000 to 5,000 ft.	60% 35%
5,000 ft. and over	60–5% 40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¾	$58.92	$63.77	$9.56	$10.64	$5.52	$5.92
¼	75.35	81.90	12.58	14.01	7.88	8.45
1	108.15	117.84	18.62	20.73	10.25	10.99
1¼	146.33	159.44	24.78	27.35	14.21	15.18
1½	174.96	190.63	33.04	36.46	17.55	18.75
2	235.39	256.48	60 58	66.85	23.41	25.00
2½	372.18	405.52	99.13	109.39	33.43	35.71
3	486.69	530.30	264.34	291.70	50.14	53.56
3½	611.52	663.96	583.74	644.16	66.86	71.42
4	745.53	807.36	674.61	774.43	83.57	89.27

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	26.50
No. 18 cotton reinforced light	18.25
No. 16 cotton reinforced light	23.00
No. 18 cotton Canvasite cord	17.50
No. 16 cotton Canvasite cord	20.50

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400 amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500)	$2.85
0–30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1 25	1.35	24
				500	2 00	2.15	12
				750	3.50	3.70	8
				1.000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$7.29	$9.38	$11.28	$17.95
12	9.66	12.45	14.17	23.62
10	12.86	16.33	18.06	32.02
8	18.17	21.78	24.15	36.75
6	.....	.....	34.38	....
4	.....	.....	47.75	.....
2	.....	.....	70.35	.....
1	.....	.....	89.73	.....
0	.....	.....	120.48	.....
00	.....	.....	144.90	.....
000	.....	.....	172.20	.....
0000	.....	.....	204.75	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	⅜ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0 55	$0.39	$0.36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32½%
Standard package	37½%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Rubber tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%